Cover Page

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of
Proposed OBD regulations for 8,500-14,000 pound highway diesel applications & >14,000 pound highway diesel and gasoline applications

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  (1)
  (i)
  (A)
  (*1*)
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  (a)
  (a)(1)
  (a)(1)(i)
  (a)(1)(i)(A)
  (a)(1)(i)(A)(1)

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Tutorial on the OBD regulations in 40 CFR Part 86

Engine certification versus Chassis certification
40 CFR part 86, subpart A contains requirements for engine certified systems.
40 CFR part 86, subpart S contains requirements for chassis certified systems.
- light-duty & heavy-duty chassis certs (i.e., "heavy as light", "HD complete vehicle").
- That is, if it's chassis certified, you need to refer to subpart S first, NOT subpart A

Section (§) numbering
Subpart A (engine cert) and Subpart S (chassis cert) use different Section numbering conventions, as discussed below.

Subpart A (engine cert) section numbering convention
OBD requirements for <14K pounds are contained in sections numbered as follows: §86.0XX-17 and §86.0XX-30, where XX represents the Model Year of applicability.

Example:
§86.007-17 contains OBD requirements for 2007 and later model years; §86.007-30 contains OBD certification requirements for 2007 and later model years. These requirements apply to subsequent model years unless superceded (e.g., §86.010-17, for the 2010 and later model years, supercedes §86.007-17).

Subpart S (chassis cert) section numbering convention
OBD requirements for any chassis certified system, regardless of weight, are contained in sections numbered as follows: §86.1806-XX where XX represents the Model Year of applicability.

Example:
§86.1806-07 contains OBD requirements for 2007 and later model years. These requirements apply to subsequent model years unless superceded (e.g., §86.1806-10, for the 2010 and later model years, supercedes §86.1806-07).

Newly added section for >14K OBD
OBD requirements for >14K pounds are contained in a newly added section within subpart A, §86.0XX-18. For >14K OBD, all OBD requirements are in subpart A since all >14K pound OBD will be engine certified.[1]

Example:
§86.010-18 contains requirements for 2010+ MYs
§86.013-18 contains requirements for 2013+ MYs
§86.016-18 contains requirements for 2016+ MYs
§86.019-18 contains requirements for 2019+ MYs

All of these sections have been added because of proposed changes to the requirements in 2013, 2016, and 2019.

Superceding sections and all the "[Reserved]" text
The text that appears in superceding sections represents the text that is being changed. Text that has NOT changed relative to earlier sections is denoted by "[Reserved.] For guidance see…" This convention is meant to make it easier to see what is being changed.

[1] There are exceptions to this general rule, as stipulated in the regulations.

PART 86 CONTROL OF EMISSIONS FROM NEW AND IN-USE HIGHWAY VEHICLES AND ENGINES

§ 86.1 Reference materials.

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(b) * * *

(2) * * *

Document No. and name	40 CFR part 86 reference
* * * *	* * *
SAE J1930, Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms_Equivalent to ISO/TR 15031-2: April 2002.	86.010-18
SAE J1939, MONTH 2006, Recommended Practice for a Serial Control and Communications Vehicle Network.	86.010-18; 86.010-38
SAE J1939-13, MONTH 2006, Off-Board Diagnostic Connector.	86.013-18
SAE J1962, Diagnostic Connector – Equivalent to ISO/DIS 15031-3: April 2002	86.013-18
SAE J1978, OBD II Scan Tool_Equivalent to ISO/DIS 15031-4: April 2002.	86.010-18
SAE J1979, E/E Diagnostic Test Modes – Equivalent to ISO/DIS 15031-5: April 2002.	86.010-18; 86.010-38
SAE J2012, Diagnostic Trouble Code Definitions – Equivalent to ISO/DIS 15031-6:April 2002	86.010-18
SAE J2403, Medium/Heavy-Duty E/E Systems Diagnosis Nomenclature; August 2004	86.007-17; 86.010-18; 86.010-38; 86.1806-07
SAE J2534, Recommended Practice for Pass-Thru Vehicle Reprogramming: February 2002	86.010-18; 86.010-38

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(5) * * *

Document No. and name	40 CFR part 86 reference
* * * *	* * *
ISO 15765-4:2001, Road Vehicles-Diagnostics on Controller Area Network (CAN) - Part 4: Requirements for emission-related systems: December 2001.	86.010-18

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Proposed OBD Regulations in Subpart A

§ 86.007-17 On-board Diagnostics for engines used in applications less than or equal to 14,000 pounds GVWR.

Section 86.007–17 includes text that specifies requirements that differ from §86.005–17. Where a paragraph in §86.005–17 is identical and applicable to §86.007–17, this may be indicated by specifying the corresponding paragraph and the statement "[Reserved]. For guidance see §86.005–17."

(a) General

(a)(1) [Reserved]. For guidance see §86.005–17.

(a)(2) An OBD system demonstrated to fully meet the requirements in §86.1806–07 may be used to meet the requirements of this section, provided that the Administrator finds that a manufacturer's decision to use the flexibility in this paragraph (a)(2) is based on good engineering judgment.

(b) Malfunction descriptions

(b) introductory text and (b)(1)(i) [Reserved]. For guidance see §86.005–17.

(b)(1)(ii) *Diesel.*

(b)(1)(ii)(A) If equipped, catalyst deterioration or malfunction before it results in exhaust NOx emissions exceeding either: 1.75 times the applicable NOx standard for engines certified to a NOx FEL greater than 0.50 g/bhp-hr; or, the applicable NOx FEL+0.5 g/bhp-hr for engines certified to a NOx FEL less than or equal to 0.50 g/bhp-hr. This requirement applies only to reduction catalysts; monitoring of oxidation catalysts is not required. This monitoring need not be done if the manufacturer can demonstrate that deterioration or malfunction of the system will not result in exceedance of the threshold.

(b)(1)(ii)(B) and (b)(2) [Reserved]. For guidance see §86.005–17.

(b)(3)(i) *Oxygen sensors and air-fuel ratio sensors downstream of aftertreatment devices.*

(b)(3)(i)(A) *Otto-cycle*. If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding 1.5 times the applicable standard or FEL for NMHC, NOx or CO.

(b)(3)(i)(B) *Diesel.* If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.04 g/bhp-hr or 0.05 g/bhp-hr PM, whichever is higher; or, 1.75 times the applicable NOx standard for engines certified to a NOx FEL greater than 0.50 g/bhp-hr; or, the applicable NOx FEL+0.5 g/bhp-hr for engines certified to a NOx FEL less than or equal to 0.50 g/bhp-hr; or, 2.5 times the applicable NMHC standard.

(b)(3)(ii) *Oxygen sensors and air-fuel ratio sensors upstream of aftertreatment devices*.

(b)(3)(ii)(A) *Otto-cycle.* If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding 1.5 times the applicable standard or FEL for NMHC, NOx or CO.

(b)(3)(ii)(B) *Diesel.* If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.04 g/bhp-hr or 0.05 g/bhp-hr PM, whichever is higher; or, 1.75 times the applicable NOx standard for engines certified to a NOx FEL greater than 0.50 g/bhp-hr; or, the applicable NOx FEL+0.5 g/bhp-hr for engines certified to a NOx FEL less than or equal to 0.50 g/bhp-hr; or, 2.5 times the applicable NMHC standard; or, 2.5 times the applicable CO standard.

(b)(3)(iii) *NOx sensors.*

(b)(3)(iii)(A) *Otto-cycle.* If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding 1.5 times the applicable standard or FEL for NMHC, NOx or CO.

(b)(3)(iii)(B) *Diesel.* If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.04 g/bhp-hr or 0.05

g/bhp-hr PM, whichever is higher; or, 1.75 times the applicable NOx standard for engines certified to a NOx FEL greater than 0.50 g/bhp-hr; or, the applicable NOx FEL+0.5 g/bhp-hr for engines certified to a NOx FEL less than or equal to 0.50 g/bhp-hr.

(b)(4) [Reserved]. For guidance see §86.005–17.

(b)(5) *Other emission control systems and components*.

(b)(5)(i) *Otto-cycle.* Any deterioration or malfunction occurring in an engine system or component directly intended to control emissions, including but not necessarily limited to, the exhaust gas recirculation (EGR) system, if equipped, the secondary air system, if equipped, and the fuel control system, singularly resulting in exhaust emissions exceeding 1.5 times the applicable emission standard or FEL for NMHC, NOx or CO. For engines equipped with a secondary air system, a functional check, as described in §86.005-17(b)(6), may satisfy the requirements of this paragraph (b)(5) provided the manufacturer can demonstrate that deterioration of the flow distribution system is unlikely. This demonstration is subject to Administrator approval and, if the demonstration and associated functional check are approved, the diagnostic system must indicate a malfunction when some degree of secondary airflow is not detectable in the exhaust system during the check. For engines equipped with positive crankcase ventilation (PCV), monitoring of the PCV system is not necessary provided the manufacturer can demonstrate to the Administrator's satisfaction that the PCV system is unlikely to fail.

(b)(5)(ii) *Diesel.* Any deterioration or malfunction occurring in an engine system or component directly intended to control emissions, including but not necessarily limited to, the exhaust gas recirculation (EGR) system, if equipped, and the fuel control system, singularly resulting in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.04 g/bhp-hr or 0.05 g/bhp-hr PM, whichever is higher; or, 1.75 times the applicable NOx standard for engines certified to a NOx FEL greater than 0.50 g/bhp-hr; or, the applicable NOx FEL+0.5 g/bhp-hr for engines certified to a NOx FEL less than or equal to 0.50 g/bhp-hr; or, 2.5 times the applicable NMHC standard; or, 2.5 times the applicable CO standard. A functional check, as described in §86.005-17(b)(6), may satisfy the requirements of this paragraph (b)(5) provided the manufacturer can demonstrate that a malfunction would not cause emissions to exceed the applicable levels. This demonstration is subject to Administrator approval. For engines equipped with crankcase ventilation (CV), monitoring of the CV system is not necessary provided the manufacturer can demonstrate to the Administrator's satisfaction that the CV system is unlikely to fail.

(b)(6) [Reserved]. For guidance see §86.005–17.

(b)(7) *Performance of OBD functions.* Any sensor or other component deterioration or malfunction which renders that sensor or component incapable of performing its function as part of the OBD system must be detected and identified on engines so equipped.

(c) through (h)

(c), (d), (e), (f), (g), and (h)(1)(i) through (h)(1)(iv) [Reserved]. For guidance see §86.005–17.

(h)(1)(v) All acronyms, definitions and abbreviations shall be formatted according to SAE J1930 "Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms" Equivalent to ISO/TR 15031–2: April 30, 2002", (Revised, April 2002), or SAE J2403, "Medium/Heavy-Duty E/E Systems Diagnosis Nomenclature: August 2004."

(h)(1)(vi) through (h)(3) [Reserved]. For guidance see §86.005–17.

(i) Deficiencies

(i) *Deficiencies and alternative fueled engines*. Upon application by the manufacturer, the Administrator may accept an OBD system as compliant even though specific requirements are not fully met. Such compliances without meeting specific requirements, or deficiencies, will be granted only if compliance would be infeasible or unreasonable considering such factors as, but not limited to: technical feasibility of the given monitor and lead time and production cycles including phase-in or phase-out of engines or vehicle designs and programmed upgrades of computers. Unmet requirements should not be carried over from the previous model year except where unreasonable hardware or software modifications would be necessary to correct the deficiency, and the manufacturer has demonstrated an acceptable level of effort toward

compliance as determined by the Administrator. Furthermore, EPA will not accept any deficiency requests that include the complete lack of a major diagnostic monitor ("major" diagnostic monitors being those for exhaust aftertreatment devices, oxygen sensor, air-fuel ratio sensor, NOx sensor, engine misfire, evaporative leaks, and diesel EGR, if equipped), with the possible exception of the special provisions for alternative fueled engines. For alternative fueled heavy-duty engines (e.g. natural gas, liquefied petroleum gas, methanol, ethanol), manufacturers may request the Administrator to waive specific monitoring requirements of this section for which monitoring may not be reliable with respect to the use of the alternative fuel. At a minimum, alternative fuel engines must be equipped with an OBD system meeting OBD requirements to the extent feasible as approved by the Administrator.

(j) CARB OBDII compliance option

(j) *California OBDII compliance option*. For heavy-duty engines used in applications weighing 14,000 pounds GVWR or less, demonstration of compliance with California OBD II requirements (Title 13 California Code of Regulations section 1968.2 (13 CCR 1968.2)), as modified and released on August 11, 2006, shall satisfy the requirements of this section, except that compliance with 13 CCR 1968.2(e)(4.2.2)(C), pertaining to 0.02 inch evaporative leak detection, and 13 CCR 1968.2(d)(1.4), pertaining to tampering protection, are not required to satisfy the requirements of this section. Also, the deficiency provisions of 13 CCR 1968.2(k) do not apply. The deficiency provisions of paragraph (i) of this section and the evaporative leak detection requirement of §86.005-17(b)(4) apply to manufacturers selecting this paragraph for demonstrating compliance. In addition, demonstration of compliance with 13 CCR 1968.2(e)(15.2.1)(C), to the extent it applies to the verification of proper alignment between the camshaft and crankshaft, applies only to vehicles equipped with variable valve timing.

(k) [Reserved]. For guidance see §86.005–17.

§ 86.007-30 Certification.

Section 86.007–30 includes text that specifies requirements that differ from §§86.094–30, 86.095–30, 86.096–30, 86.098–30, 86.001–30 or 86.004–30. Where a paragraph in §86.094–30, §86.095–30, §86.096–30, §86.098–30, §86.001–30 or §86.004–30 is identical and applicable to §86.007–30, this may be indicated by specifying the corresponding paragraph and the statement "[Reserved]. For guidance see §86.094–30." or "[Reserved]. For guidance see §86.095–30." or "[Reserved]. For guidance see §86.096–30." or "[Reserved]. For guidance see §86.098–30." or "[Reserved]. For guidance see §86.001–30." or "[Reserved]. For guidance see 86.004–30."

(a) thru (e)

(a)(1) and (a)(2) [Reserved]. For guidance see §86.094–30.
(a)(3)(i) through (a)(4)(ii) [Reserved]. For guidance see §86.004-30.
(a)(4)(iii) introductory text through (a)(4)(iii)(C) [Reserved]. For guidance see §86.094–30.
(a)(4)(iv) introductory text [Reserved]. For guidance see §86.095–30.
(a)(4)(iv)(A)–(a)(9) [Reserved]. For guidance see §86.094–30.
(a)(10) and (a)(11) [Reserved]. For guidance see §86.004-30.
(a)(12) [Reserved]. For guidance see §86.094–30.
(a)(13) [Reserved]. For guidance see §86.095–30.
(a)(14) [Reserved]. For guidance see §86.094–30.
(a) (15)–(18) [Reserved]. For guidance see §86.096–30.
(a)(19) [Reserved]. For guidance see §86.098–30.
(a)(20) [Reserved]. For guidance see §86.001–30.
(a)(21) [Reserved]. For guidance see §86.004-30.
(b)(1) introductory text through (b)(1)(ii)(A) [Reserved]. For guidance see §86.094–30.

(b)(1)(ii)(B) [Reserved]. For guidance see §86.004-30.
(b)(1)(ii)(C) [Reserved]. For guidance see §86.094–30.
(b)(1)(ii)(D) [Reserved]. For guidance see §86.004-30.
(b)(1)(iii) and (b)(1)(iv) [Reserved]. For guidance see §86.094–30.
(b)(2) [Reserved]. For guidance see §86.098–30.
(b)(3)–(b)(4)(i) [Reserved]. For guidance see §86.094–30.
(b)(4)(ii) introductory text [Reserved]. For guidance see §86.098–30.
(b)(4)(ii)(A) [Reserved]. For guidance see §86.094–30.
(b)(4)(ii)(B)–(b)(4)(iv) [Reserved]. For guidance see §86.098–30.
(b)(5)–(e) [Reserved]. For guidance see §86.094–30.

(f) OBD certification

(f) introductory text through (f)(1)(i) [Reserved]. For guidance see §86.004-30.
(f)(1)(ii) *Diesel*.
(f)(1)(ii)(A) If monitored for emissions performance—a catalyst is replaced with a deteriorated or defective catalyst, or an electronic simulation of such, resulting in exhaust emissions exceeding 1.75 times the applicable NOx standard for engines certified to a NOx FEL greater than 0.50 g/bhp-hr; or, the applicable NOx FEL+0.5 g/bhp-hr for engines certified to a NOx FEL less than or equal to 0.50 g/bhp-hr. This requirement applies only to reduction catalysts.
(f)(1)(ii)(B) If monitored for performance—a particulate trap is replaced with a trap that has catastrophically failed, or an electronic simulation of such.
(f)(2) [Reserved]. For guidance see §86.004-30.
(f)(3)(i) *Oxygen sensors and air-fuel ratio sensors downstream of aftertreatment devices.*
(f)(3)(i)(A) *Otto-cycle*. If so equipped, any oxygen sensor or air-fuel ratio sensor located downstream of aftertreatment devices is replaced with a deteriorated or defective sensor, or an electronic simulation of such, resulting in exhaust emissions exceeding 1.5 times the applicable standard or FEL for NMHC, NOx or CO.
(f)(3)(i)(B) *Diesel*. If so equipped, any oxygen sensor or air-fuel ratio sensor located downstream of aftertreatment devices is replaced with a deteriorated or defective sensor, or an electronic simulation of such, resulting in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.04 g/bhp-hr or 0.05 g/bhp-hr PM, whichever is higher; or, 1.75 times the applicable NOx standard for engines certified to a NOx FEL greater than 0.50 g/bhp-hr; or, the applicable NOx FEL+0.5 g/bhp-hr for engines certified to a NOx FEL less than or equal to 0.50 g/bhp-hr; or, 2.5 times the applicable NMHC standard.
(f)(3)(ii) *Oxygen sensors and air-fuel ratio sensors upstream of aftertreatment devices*.
(f)(3)(ii)(A) *Otto-cycle*. If so equipped, any oxygen sensor or air-fuel ratio sensor located upstream of aftertreatment devices is replaced with a deteriorated or defective sensor, or an electronic simulation of such, resulting in exhaust emissions exceeding 1.5 times the applicable standard or FEL for NMHC, NOx or CO.
(f)(3)(ii)(B) *Diesel*. If so equipped, any oxygen sensor or air-fuel ratio sensor located upstream of aftertreatment devices is replaced with a deteriorated or defective sensor, or an electronic simulation of such, resulting in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.04 g/bhp-hr or 0.05 g/bhp-hr PM, whichever is higher; or, 1.75 times the applicable NOx standard for engines certified to a NOx FEL greater than 0.50 g/bhp-hr; or, the applicable NOx FEL+0.5 g/bhp-hr for engines certified to a NOx FEL less than or equal to 0.50 g/bhp-hr; or, 2.5 times the applicable NMHC standard; or, 2.5 times the applicable CO standard.
(f)(3)(iii) *NOx sensors*.
(f)(3)(iii)(A) *Otto-cycle*. If so equipped, any NOx sensor is replaced with a deteriorated or defective sensor, or an electronic simulation of such, resulting in exhaust emissions exceeding 1.5 times the applicable standard or FEL for NMHC, NOx or CO.
(f)(3)(iii)(B) *Diesel*. If so equipped, any NOx sensor is replaced with a deteriorated or defective sensor, or an electronic simulation of such, resulting in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.04 g/bhp-hr or 0.05 g/bhp-hr PM, whichever is higher; or, 1.75 times the applicable NOx standard for engines certified to a NOx FEL greater than 0.50 g/bhp-hr; or, the applicable NOx FEL+0.5 g/bhp-hr for engines certified to a NOx FEL less than or equal to 0.50 g/bhp-hr.

(f)(4) [Reserved]. For guidance see §86.004-30.

(f)(5)(i) *Otto-cycle*. A malfunction condition is induced in any emission-related engine system or component, including but not necessarily limited to, the exhaust gas recirculation (EGR) system, if equipped, the secondary air system, if equipped, and the fuel control system, singularly resulting in exhaust emissions exceeding 1.5 times the applicable emission standard or FEL for NMHC, NOx, or CO.

(f)(5)(ii) *Diesel*. A malfunction condition is induced in any emission-related engine system or component, including but not necessarily limited to, the exhaust gas recirculation (EGR) system, if equipped, and the fuel control system, singularly resulting in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.04 g/bhp-hr or 0.05 g/bhp-hr PM, whichever is higher; or, 1.75 times the applicable NOx standard for engines certified to a NOx FEL greater than 0.50 g/bhp-hr; or, the applicable NOx FEL+0.5 g/bhp-hr for engines certified to a NOx FEL less than or equal to 0.50 g/bhp-hr; or, 2.5 times the applicable NMHC standard; or, 2.5 times the applicable CO standard.

(f)(6) [Reserved]. For guidance see §86.004-30.

§ 86.010-2 Definitions.

The definitions of §86.004–2 continue to apply to 2004 and later model year vehicles. The definitions listed in this section apply beginning with the 2010 model year.

Drive cycle or driving cycle means operation that consists of engine startup and engine shutoff during which a given onboard diagnostic (OBD) monitor makes a diagnostic decision. A drive cycle need not consist of all OBD monitors making a diagnostic decision during the engine startup and engine shutoff cycle. An engine restart following an engine shutoff that has been neither commanded by the vehicle operator nor by the engine control strategy but caused by an event such as an engine stall may be considered a new drive cycle or a continuation of the existing drive cycle.

DTC means diagnostic trouble code.

Engine start as used in §86.010-18 means the point when the engine reaches a speed 150 rpm below the normal, warmed-up idle speed (as determined in the drive position for vehicles equipped with an automatic transmission). For hybrid vehicles or for engines employing alternative engine start hardware or strategies (e.g., integrated starter and generators.), the manufacturer may use an alternative definition for engine start (e.g., key-on) provided the alternative definition is based on equivalence to an engine start for a conventional vehicle.

Functional check, in the context of onboard diagnostics, means verifying that a component and/or system that receives information from a control computer responds properly to a command from the control computer.

Ignition cycle as used in §86.010-18 means a cycle that begins with engine start, meets the engine start definition for at least two seconds plus or minus one second, and ends with engine shutoff.

Limp-home operation as used in §86.010-18 means an operating mode that an engine is designed to enter upon determining that normal operation cannot be maintained. In general, limp-home operation implies that a component or system is not operating properly or is believed to be not operating properly.

Malfunction means the conditions have been met that require the activation of an OBD malfunction indicator light and storage of a DTC.

MIL-on DTC means the diagnostic trouble code stored when an OBD system has detected and confirmed that a malfunction exists (e.g., typically on the second drive cycle during which a given OBD monitor has evaluated a system or component). Industry standards may refer to this as a confirmed or an active DTC.

Pending DTC means the diagnostic trouble code stored upon the detection of a potential malfunction.

Permanent DTC means a DTC that corresponds to a MIL-on DTC and is stored in non-volatile random access memory (NVRAM). A permanent DTC can only be erased by the OBD system itself and cannot be erased through human interaction with the OBD system or any onboard computer.
Previous-MIL-on DTC means a DTC that corresponds to a MIL-on DTC but is distinguished by representing a malfunction that the OBD system has determined no longer exists but for which insufficient operation has occurred to satisfy the DTC erasure provisions.
Potential malfunction means that conditions have been detected that meet the OBD malfunction criteria but for which more drive cycles are allowed to provide further evaluation prior to confirming that a malfunction exists.
Rationality check, in the context of onboard diagnostics, means verifying that a component that provides input to a control computer provides an accurate input to the control computer while in the range of normal operation and when compared to all other available information.
Similar conditions, in the context of onboard diagnostics, means engine conditions having an engine speed within 375 rpm, load conditions within 20 percent, and the same warm up status (i.e., cold or hot). The manufacturer may use other definitions of similar conditions based on comparable timeliness and reliability in detecting similar engine operation.

§ 86.010-17 On-board Diagnostics for engines used in applications less than or equal to 14,000 pounds GVWR.

Section 86.010–17 includes text that specifies requirements that differ from §86.005–17 and §86.007–17. Where a paragraph in §86.005–17 or §86.007–17 is identical and applicable to §86.010–17, this may be indicated by specifying the corresponding paragraph and the statement "[Reserved]. For guidance see §86.005–17." or "[Reserved]. For guidance see §86.007–17."

(a) General

(a) *General*.

(a)(1) All heavy-duty engines intended for use in a heavy-duty vehicle weighing 14,000 pounds GVWR or less must be equipped with an on-board diagnostic (OBD) system capable of monitoring all emission-related engine systems or components during the applicable useful life. All monitored systems and components must be evaluated periodically, but no less frequently than once per applicable certification test cycle as defined in Appendix I, paragraph (f), of this part, or similar trip as approved by the Administrator.

(a)(2) An OBD system demonstrated to fully meet the requirements in §86.1806–10 may be used to meet the requirements of this section, provided that the Administrator finds that a manufacturer's decision to use the flexibility in this paragraph (a)(2) is based on good engineering judgment.

(b) Malfunction descriptions

(b) introductory text and (b)(1)(i) [Reserved]. For guidance see §86.005–17.

(b)(1)(ii) *Diesel.*

(b)(1)(ii)(A) If equipped, reduction catalyst deterioration or malfunction before it results in exhaust NOx emissions exceeding the applicable NOx FEL+0.3 g/bhp-hr. If equipped, oxidation catalyst deterioration or malfunction before it results in exhaust NMHC emissions exceeding 2.5 times the applicable NMHC standard. These catalyst monitoring requirements need not be done if the manufacturer can demonstrate that deterioration or malfunction of the system will not result in exceedance of the threshold.

(b)(1)(ii)(B) If equipped, diesel particulate trap deterioration or malfunction before it results in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.04 g/bhp-hr or 0.05 g/bhp-hr PM, whichever is higher; or, exhaust NMHC emissions exceeding 2.5 times the

applicable NMHC standard. Catastrophic failure of the particulate trap must also be detected. In addition, the absence of the particulate trap or the trapping substrate must be detected.

(b)(2) [Reserved]. For guidance see §86.005–17.

(b)(3)(i) *Oxygen sensors and air-fuel ratio sensors downstream of aftertreatment devices.*

(b)(3)(i)(A) *Otto-cycle*. If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding 1.5 times the applicable standard or FEL for NMHC, NOx or CO.

(b)(3)(i)(B) *Diesel.* If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.04 g/bhp-hr or 0.05 g/bhp-hr PM, whichever is higher; or, the applicable NOx FEL+0.3 g/bhp-hr; or, 2.5 times the applicable NMHC standard.

(b)(3)(ii) *Oxygen sensors and air-fuel ratio sensors upstream of aftertreatment devices*.

(b)(3)(ii)(A) *Otto-cycle.* If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding 1.5 times the applicable standard or FEL for NMHC, NOx or CO.

(b)(3)(ii)(B) *Diesel.* If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.02 g/bhp-hr or 0.03 g/bhp-hr PM, whichever is higher; or, the applicable NOx FEL+0.3 g/bhp-hr; or, 2.5 times the applicable NMHC standard; or, 2.5 times the applicable CO standard.

(b)(3)(iii) *NOx sensors.*

(b)(3)(iii)(A) *Otto-cycle.* If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding 1.5 times the applicable standard or FEL for NMHC, NOx or CO.

(b)(3)(iii)(B) *Diesel.* If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.04 g/bhp-hr or 0.05 g/bhp-hr PM, whichever is higher; or, the applicable NOx FEL+0.3 g/bhp-hr.

(b)(4) [Reserved]. For guidance see §86.005–17.

(b)(5) *Other emission control systems and components*.

(b)(5)(i) *Otto-cycle.* Any deterioration or malfunction occurring in an engine system or component directly intended to control emissions, including but not necessarily limited to, the exhaust gas recirculation (EGR) system, if equipped, the secondary air system, if equipped, and the fuel control system, singularly resulting in exhaust emissions exceeding 1.5 times the applicable emission standard or FEL for NMHC, NOx or CO. For engines equipped with a secondary air system, a functional check, as described in §86.005-17(b)(6), may satisfy the requirements of this paragraph (b)(5) provided the manufacturer can demonstrate that deterioration of the flow distribution system is unlikely. This demonstration is subject to Administrator approval and, if the demonstration and associated functional check are approved, the diagnostic system must indicate a malfunction when some degree of secondary airflow is not detectable in the exhaust system during the check. For engines equipped with positive crankcase ventilation (PCV), monitoring of the PCV system is not necessary provided the manufacturer can demonstrate to the Administrator's satisfaction that the PCV system is unlikely to fail.

(b)(5)(ii) *Diesel.* Any deterioration or malfunction occurring in an engine system or component directly intended to control emissions, including but not necessarily limited to, the exhaust gas recirculation (EGR) system, if equipped, and the fuel control system, singularly resulting in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.02 g/bhp-hr or 0.03 g/bhp-hr PM, whichever is higher; or, the applicable NOx FEL+0.3 g/bhp-hr; or, 2.5x the applicable NMHC standard; or, 2.5x the applicable CO standard. A functional check, as described in §86.005-17(b)(6), may satisfy the requirements of this paragraph (b)(5) provided the manufacturer can demonstrate that a malfunction would not cause emissions to exceed the applicable levels. This demonstration is subject to Administrator approval. For engines equipped with crankcase ventilation (CV), monitoring of the CV system is not necessary provided the manufacturer can demonstrate to the Administrator's satisfaction that the CV system is unlikely to fail.

(b)(6) [Reserved]. For guidance see §86.005–17.

(b)(7) [Reserved]. For guidance see §86.007–17.

(c) MIL

(c) [Reserved]. For guidance see §86.005–17.

(d) MIL illumination

(d) *MIL illumination*.

(d)(1) The MIL must illuminate and remain illuminated when any of the conditions specified in paragraph (b) of this section are detected and verified, or whenever the engine control enters a default or secondary mode of operation considered abnormal for the given engine operating conditions. The MIL must blink once per second under any period of operation during which engine misfire is occurring and catalyst damage is imminent. If such misfire is detected again during the following driving cycle (i.e., operation consisting of, at a minimum, engine start-up and engine shut-off) or the next driving cycle in which similar conditions are encountered, the MIL must maintain a steady illumination when the misfire is not occurring and then remain illuminated until the MIL extinguishing criteria of this section are satisfied. The MIL must also illuminate when the vehicle's ignition is in the “key-on” position before engine starting or cranking and extinguish after engine starting if no malfunction has previously been detected. If a fuel system or engine misfire malfunction has previously been detected, the MIL may be extinguished if the malfunction does not reoccur during three subsequent sequential trips during which similar conditions are encountered and no new malfunctions have been detected. Similar conditions are defined as engine speed within 375 rpm, engine load within 20 percent, and engine warm-up status equivalent to that under which the malfunction was first detected. If any malfunction other than a fuel system or engine misfire malfunction has been detected, the MIL may be extinguished if the malfunction does not reoccur during three subsequent sequential trips during which the monitoring system responsible for illuminating the MIL functions without detecting the malfunction, and no new malfunctions have been detected. Upon Administrator approval, statistical MIL illumination protocols may be employed, provided they result in comparable timeliness in detecting a malfunction and evaluating system performance, i.e., three to six driving cycles would be considered acceptable.

(d)(2) *Drive cycle or driving cycle*, in the context of this section §86.010-17, the definition for drive cycle or driving cycle given in §86.010-2 is enhanced. A drive cycle means an OBD trip that consists of engine startup and engine shutoff and includes the period of engine off time up to the next engine startup. For vehicles that employ engine shutoff strategies (e.g., engine shutoff at idle), the manufacturer may use an alternative definition for drive cycle (e.g., key-on followed by key-off). Any alternative definition must be based on equivalence to engine startup and engine shutoff signaling the beginning and ending of a single driving event for a conventional vehicle. For applications that span 14,000 pounds GVWR, the manufacturer may use the drive cycle definition of §86.010-18 in lieu of the definition in this paragraph.

(e) thru (k)

(e), (f), (g), and (h)(1)(i) through (h)(1)(iv) [Reserved]. For guidance see §86.005–17.
(h)(1)(v) [Reserved]. For guidance see §86.007–17.
(h)(1)(vi) through (h)(3) [Reserved]. For guidance see §86.005–17.
(i) and (j) [Reserved]. For guidance see §86.007–17.
(k) [Reserved.]

§ 86.010-18 On-board Diagnostics for engines used in applications greater than 14,000 pounds GVWR.

(a) General

(a) *General*. According to the implementation schedule shown in paragraph (o) of this section, heavy-duty engines intended for use in a heavy-duty vehicle weighing more than 14,000 pounds GVWR must be equipped with an on-board diagnostic (OBD) system capable of monitoring all emission-related engine systems or components during the life of the engine. The OBD system is required to detect all malfunctions specified in paragraphs (g), (h), and (i) of this

section although the OBD system is not required to use a unique monitor to detect each of those malfunctions.

(a)(1) When the OBD system detects a malfunction, it must store a pending, a MIL-on, or a previous-MIL-on diagnostic trouble code (DTC) in the onboard computer's memory. A malfunction indicator light (MIL) must also be activated as specified in paragraph (b) of this section.

(a)(2) The OBD system must be equipped with a data link connector to provide access to the stored DTCs as specified in paragraph (k)(2) of this section.

(a)(3) The OBD system cannot be programmed or otherwise designed to deactivate based on age and/or mileage. This requirement does not alter existing law and enforcement practice regarding a manufacturer's liability for an engine beyond its regulatory useful life, except where an engine has been programmed or otherwise designed so that an OBD system deactivates based on age and/or mileage of the engine.

(a)(4) *Drive cycle or driving cycle*, in the context of this section, the definition for drive cycle or driving cycle given in §86.010-2 is enhanced. A drive cycle means an OBD trip that meets any of the conditions of paragraphs (a)(4)(i) through (a)(4)(iv) of this section. Further, for OBD monitors that run during engine-off conditions, the period of engine-off time following engine shutoff and up to the next engine start may be considered part of the drive cycle for the conditions of paragraphs (a)(4)(i) and (a)(4)(iv) of this section. For engines/vehicles that employ engine shutoff OBD monitoring strategies that do not require the vehicle operator to restart the engine to continue vehicle operation (e.g., a hybrid bus with engine shutoff at idle), the manufacturer may use an alternative definition for drive cycle (e.g., key-on followed by key-off). Any alternative definition must be based on equivalence to engine startup and engine shutoff signaling the beginning and ending of a single driving event for a conventional vehicle. For engines that are not likely to be routinely operated for long continuous periods of time, a manufacturer may also request approval to use an alternative definition for drive cycle (e.g., solely based on engine start and engine shutoff without regard to four hours of continuous engine-on time). Administrator approval of the alternative definition will be based on manufacturer-submitted data and/or information demonstrating the typical usage, operating habits, and/or driving patterns of these vehicles.

(a)(4)(i) Begins with engine start and ends with engine shutoff;

(a)(4)(ii) Begins with engine start and ends after four hours of continuous engine-on operation;

(a)(4)(iii) Begins at the end of the previous four hours of continuous engine-on operation and ends after four hours of continuous engine-on operation; or

(a)(4)(iv) Begins at the end of the previous four hours of continuous engine-on operation and ends with engine shutoff.

(b) MIL and DTCs

(b) *Malfunction indicator light (MIL) and Diagnostic Trouble Codes (DTC).* The OBD system must incorporate a malfunction indicator light (MIL) or equivalent and must store specific types of diagnostic trouble codes (DTC).

(b)(1) *MIL specifications.*

(b)(1)(i) [Reserved.]

(b)(1)(ii) The OBD system must activate the MIL when the ignition is in the key-on/engine-off position before engine cranking to indicate that the MIL is functional. The MIL shall be activated continuously during this functional check for a minimum of 5 seconds. During this MIL key-on functional check, the data stream value (see paragraph (k)(4)(ii) of this section) for MIL status must indicate "commanded off" unless the OBD system has detected a malfunction and has stored a MIL-on DTC. This MIL key-on functional check is not required during vehicle operation in the key-on/engine-off position subsequent to the initial engine cranking of an ignition cycle (e.g., due to an engine stall or other non-commanded engine shutoff).

(b)(1)(iii) As an option, the MIL may be used to indicate readiness status (see paragraph (k)(4)(i) of this section) in a standardized format in the key-on/engine-off position.

(b)(1)(iv) A manufacturer may also use the MIL to indicate which, if any, DTCs are currently stored (e.g., to "blink" the stored DTCs). Such use must not activate unintentionally during routine driver operation.

(b)(1)(v) [Reserved.]

(b)(2) *MIL activation and DTC storage protocol.*

(b)(2)(i) Within 10 seconds of detecting a potential malfunction, the OBD system must store a pending DTC that identifies the potential malfunction.

(b)(2)(ii) If the potential malfunction is again detected before the end of the next drive cycle during which monitoring occurs (i.e., the potential malfunction has been confirmed as a malfunction), then within 10 seconds of such detection the OBD system must activate the MIL continuously and store a MIL-on DTC. If the potential malfunction is not detected before the end of the next drive cycle during which monitoring occurs (i.e., there is no indication of the malfunction at any time during the drive cycle), the corresponding pending DTC should be erased at the end of the drive cycle. Similarly, if a malfunction is detected for the first time and confirmed on a given drive cycle without need for further evaluation, then within 10 seconds of such detection the OBD system must activate the MIL continuously and store a MIL-on DTC.

(b)(2)(iii) A manufacturer may request Administrator approval to employ alternative statistical MIL activation and DTC storage protocols to those specified in paragraphs (b)(2)(i) and (b)(2)(ii) of this section. Approval will depend upon the manufacturer providing data and/or engineering evaluations that demonstrate that the alternative protocols can evaluate system performance and detect malfunctions in a manner that is equally effective and timely. Strategies requiring on average more than six drive cycles for MIL activation will not be accepted.

(b)(2)(iv) The OBD system must store a "freeze frame" of the operating conditions (as defined in paragraph (k)(4)(iii) of this section) present upon detecting a malfunction or a potential malfunction. In the event that a pending DTC has matured to a MIL-on DTC, the manufacturer shall either retain the currently stored freeze frame conditions or replace the stored freeze frame with freeze frame conditions regarding the MIL-on DTC. Any freeze frame stored in conjunction with any pending DTC or MIL-on DTC should be erased upon erasure of the corresponding DTC.

(b)(2)(v) If the engine enters a limp-home mode of operation that can affect emissions or the performance of the OBD system, or in the event of a malfunction of an onboard computer(s) itself that can affect the performance of the OBD system, the OBD system must activate the MIL and store a MIL-on DTC within 10 seconds to inform the vehicle operator. If the limp-home mode of operation is recoverable (i.e., operation automatically returns to normal at the beginning of the following ignition cycle), the OBD system may wait to activate the MIL and store the MIL-on DTC if the limp-home mode of operation is again entered before the end of the next ignition cycle rather than activating the MIL within 10 seconds on the first drive cycle during which the limp-home mode of operation is entered.

(b)(2)(vi) Before the end of an ignition cycle, the OBD system must store a permanent DTC(s) that corresponds to any stored MIL-on DTC(s).

(b)(3) *MIL deactivation and DTC erasure protocol*.

(b)(3)(i) *Deactivating the MIL*. Except as otherwise provided for in paragraph (g)(6)(iv)(B) of this section for empty reductant tanks, and paragraphs (h)(1)(iv)(F), (h)(2)(viii), and (h)(7)(iv)(B) of this section for gasoline fuel system, misfire, and evaporative system malfunctions, once the MIL has been activated, it may be deactivated after three subsequent sequential drive cycles during which the monitoring system responsible for activating the MIL functions and the previously detected malfunction is no longer present and provided no other malfunction has been detected that would independently activate the MIL according to the requirements outlined in paragraph (b)(2) of this section.

(b)(3)(ii) *Erasing a MIL-on DTC*. The OBD system may erase a MIL-on DTC if the identified malfunction has not again been detected in at least 40 engine warm up cycles and the MIL is presently not activated for that malfunction. The OBD system may also erase a MIL-on DTC upon deactivating the MIL according to paragraph (b)(3)(i) of this section provided a previous-MIL-on DTC is stored upon erasure of the MIL-on DTC. The OBD system may erase a previous-MIL-on DTC if the identified malfunction has not again been detected in at least 40 engine warm up cycles and the MIL is presently not activated for that malfunction.

(b)(3)(iii) *Erasing a permanent DTC*. The OBD system can erase a permanent DTC only if either of the following conditions occur:

(b)(3)(iii)(A) The OBD system itself determines that the malfunction that caused the corresponding MIL-on DTC to be stored is no longer present and is not commanding activation of the MIL, concurrent with the requirements of paragraph (b)(3)(i) of this section.

(b)(3)(iii)(B) Subsequent to erasing the DTC information from the on-board computer (i.e., through the use of a scan tool or a battery disconnect), the OBD monitor for the malfunction that caused the permanent DTC to be stored has executed the minimum number of monitoring events necessary for MIL activation and has determined that the malfunction is no longer present.

(b)(4) *Exceptions to MIL and DTC requirements*.

(b)(4)(i) If a limp-home mode of operation causes a overt indication (e.g., activation of a red engine shut-down warning light) such that the driver is certain to respond and have the problem corrected, a manufacturer may choose not to activate the MIL as required by paragraph (b)(2)(v) of this section. Additionally, if an auxiliary emission control device has been properly activated as approved by the Administrator, a manufacturer may choose not to activate the MIL.

(b)(4)(ii) For gasoline engines, a manufacturer may choose to meet the MIL and DTC requirements in §86.010-17 in lieu of meeting the requirements of paragraph (b) of §86.010-18.

(c) Monitoring conditions

(c) *Monitoring conditions*. The OBD system must monitor and detect the malfunctions specified in paragraphs (g), (h), and (i) of this section under the following general monitoring conditions. The more specific monitoring conditions of paragraph (d) of this section are sometimes required according to the provisions of paragraphs (g), (h), and (i) of this section.

(c)(1) As specifically provided for in paragraphs (g), (h), and (i) of this section, the monitoring conditions for detecting malfunctions must be technically necessary to ensure robust detection of malfunctions (e.g., avoid false passes and false indications of malfunctions); designed to ensure monitoring will occur under conditions that may reasonably be expected to be encountered in normal vehicle operation and normal vehicle use; and, designed to ensure monitoring will occur during the FTP transient test cycle contained in Appendix I paragraph (f), of this part, or similar drive cycle as approved by the Administrator.

(c)(2) Monitoring must occur at least once per drive cycle in which the monitoring conditions are met.

(c)(3) Manufacturers may request approval to define monitoring conditions that are not encountered during the FTP cycle as required in paragraph (c)(1) of this section. In evaluating the manufacturer's request, the Administrator will consider the degree to which the requirement to run during the FTP transient cycle restricts monitoring during in-use operation, the technical necessity for defining monitoring conditions that are not encountered during the FTP cycle, data and/or an engineering evaluation submitted by the manufacturer that demonstrate that the component/system does not normally function during the FTP, whether monitoring is otherwise not feasible during the FTP cycle, and/or the ability of the manufacturer to demonstrate that the monitoring conditions satisfy the minimum acceptable in-use monitor performance ratio requirement as defined in paragraph (d) of this section.

(d) In-use performance tracking

(d) *In-use performance tracking*. As specifically required in paragraphs (g), (h), and (i) of this section, the OBD system must monitor and detect the malfunctions specified in paragraphs (g), (h), and (i) of this section according to the criteria of this paragraph (d). The OBD system is not required to track and report in-use performance for monitors other than those specifically identified in paragraph (d)(1) of this section.

(d)(1) The manufacturer must implement software algorithms in the OBD system to individually track and report the in-use performance of the following monitors, if equipped, in the standardized format specified in paragraph (e) of this section: NMHC converting catalyst (paragraph (g)(5) of this section); NOx converting catalyst (paragraph (g)(6) of this section; gasoline catalyst (paragraph (h)(6) of this section); exhaust gas sensor (paragraph (g)(9) or (h)(8) of this section); evaporative system (paragraph (h)(7) of this section); EGR system (paragraph

(g)(3) or (h)(3) of this section); VVT system (paragraph (g)(10) or (h)(9) of this section); secondary air system (paragraph (h)(5) of this section); DPF system (paragraph (g)(8) of this section); boost pressure control system (paragraph (g)(4) of this section); and, NOx adsorber system (paragraph (g)(7) of this section).

(d)(1)(i) The manufacturer shall not use the calculated ratio specified in paragraph (d)(2) of this section or any other indication of monitor frequency as a monitoring condition for a monitor (e.g., using a low ratio to enable more frequent monitoring through diagnostic executive priority or modification of other monitoring conditions, or using a high ratio to enable less frequent monitoring).

(d)(1)(ii) [Reserved.]

(d)(2) *In-use performance ratio definition*. For monitors required to meet the requirements of paragraph (d) of this section, the performance ratio must be calculated in accordance with the specifications of this paragraph (d)(2).

(d)(2)(i) The numerator of the performance ratio is defined as the number of times a vehicle has been operated such that all monitoring conditions have been encountered that are necessary for the specific monitor to detect a malfunction.

(d)(2)(ii) The denominator is defined as the number of times a vehicle has been operated in accordance with the provisions of paragraph (d)(4) of this section.

(d)(2)(iii) The performance ratio is defined as the numerator divided by the denominator.

(d)(3) *Specifications for incrementing the numerator*.

(d)(3)(i) Except as provided for in paragraph (d)(3)(v) of this paragraph (d)(3), the numerator, when incremented, must be incremented by an integer of one. The numerator shall not be incremented more than once per drive cycle.

(d)(3)(ii) The numerator for a specific monitor must be incremented within 10 seconds if and only if the following criteria are satisfied on a single drive cycle:

(d)(3)(ii)(A) Every monitoring condition has been satisfied that is necessary for the specific monitor to detect a malfunction and store a pending DTC, including applicable enable criteria, presence or absence of related DTCs, sufficient length of monitoring time, and diagnostic executive priority assignments (e.g., diagnostic “A” must execute prior to diagnostic “B”). For the purpose of incrementing the numerator, satisfying all the monitoring conditions necessary for a monitor to determine that the monitor is not malfunctioning shall not, by itself, be sufficient to meet this criteria.

(d)(3)(ii)(B) For monitors that require multiple stages or events in a single drive cycle to detect a malfunction, every monitoring condition necessary for all events to complete must be satisfied.

(d)(3)(ii)(C) For monitors that require intrusive operation of components to detect a malfunction, a manufacturer must request approval of the strategy used to determine that, had a malfunction been present, the monitor would have detected the malfunction. Administrator approval of the request will be based on the equivalence of the strategy to actual intrusive operation and the ability of the strategy to determine accurately if every monitoring condition was satisfied that was necessary for the intrusive event to occur.

(d)(3)(ii)(D) For the secondary air system monitor, the criteria in paragraphs (d)(3)(ii)(A) through (d)(3)(ii)(C) of this section are satisfied during normal operation of the secondary air system. Monitoring during intrusive operation of the secondary air system later in the same drive cycle for the sole purpose of monitoring shall not, by itself, be sufficient to meet these criteria.

(d)(3)(iii) For monitors that can generate results in a “gray zone” or “non-detection zone” (i.e., monitor results that indicate neither a properly operating system nor a malfunctioning system) or in a “non-decision zone” (e.g., monitors that increment and decrement counters until a pass or fail threshold is reached), the numerator, in general, shall not be incremented when the monitor indicates a result in the “non-detection zone” or prior to the monitor reaching a complete decision. When necessary, the Administrator will consider data and/or engineering analyses submitted by the manufacturer demonstrating the expected frequency of results in the “non-detection zone” and the ability of the monitor to determine accurately, had an actual malfunction been present, whether or not the monitor would have detected a malfunction instead of a result in the “non-detection zone.”

(d)(3)(iv) For monitors that run or complete their evaluation with the engine off, the numerator must be incremented either within 10 seconds of the monitor completing its evaluation in the engine off state, or during the first 10 seconds of engine start on the subsequent drive cycle.

(d)(3)(v) Manufacturers that use alternative statistical MIL activation protocols as allowed in paragraph (b)(2)(iii) of this section for any of the monitors requiring a numerator, are required to increment the numerator(s) appropriately. The manufacturer may be required to provide supporting data and/or engineering analyses demonstrating both the equivalence of their incrementing approach to the incrementing specified in this paragraph (d)(3) for monitors using the standard MIL activation protocol.

(d)(4) *Specifications for incrementing the denominator*.

(d)(4)(i) The denominator, when incremented, must be incremented by an integer of one. The denominator shall not be incremented more than once per drive cycle.

(d)(4)(ii) The denominator for each monitor must be incremented within 10 seconds if and only if the following criteria are satisfied on a single drive cycle:

(d)(4)(ii)(A) Cumulative time since the start of the drive cycle is greater than or equal to 600 seconds while at an elevation of less than 8,000 feet (2,400 meters) above sea level and at an ambient temperature of greater than or equal to 20 degrees Fahrenheit (-7 C);

(d)(4)(ii)(B) Cumulative gasoline engine operation at or above 25 miles per hour or diesel engine operation at or above 15% calculated load, either of which occurs for greater than or equal to 300 seconds while at an elevation of less than 8,000 feet (2,400 meters) above sea level and at an ambient temperature of greater than or equal to 20 degrees Fahrenheit (-7 C); and

(d)(4)(ii)(C) Continuous vehicle operation at idle (e.g., accelerator pedal released by driver and vehicle speed less than or equal to one mile per hour) for greater than or equal to 30 seconds while at an elevation of less than 8,000 feet (2,400 meters) above sea level and at an ambient temperature of greater than or equal to 20 degrees Fahrenheit (-7 C).

(d)(4)(iii) In addition to the requirements of paragraph (d)(4)(ii) of this section, the evaporative system monitor denominator(s) may be incremented if and only if:

(d)(4)(iii)(A) Cumulative time since the start of the drive cycle is greater than or equal to 600 seconds while at an ambient temperature of greater than or equal to 40 degrees Fahrenheit (4 C) but less than or equal to 95 degrees Fahrenheit (35 C); and,

(d)(4)(iii)(B) Engine cold start occurs with the engine coolant temperature greater than or equal to 40 degrees Fahrenheit (4 C) but less than or equal to 95 degrees Fahrenheit (35 C) and less than or equal to 12 degrees Fahrenheit (7 C) higher than the ambient temperature.

(d)(4)(iv) In addition to the requirements of paragraph (d)(4)(ii) of this section, the denominator(s) for the following monitors may be incremented if and only if the component or strategy is commanded “on” for a time greater than or equal to 10 seconds. For purposes of determining this commanded “on” time, the OBD system shall not include time during intrusive operation of any of the components or strategies that occurs later in the same drive cycle for the sole purpose of monitoring.

(d)(4)(iv)(A) Secondary air system (paragraph (h)(5) of this section)

(d)(4)(iv)(B) Cold start emission reduction strategy (paragraph (h)(4) of this section)

(d)(4)(iv)(C) Components or systems that operate only at engine start-up (e.g., glow plugs, intake air heaters) and are subject to monitoring under “other emission control systems” (paragraph (i)(4) of this section) or comprehensive component output components (paragraph (i)(3)(iii) of this section).

(d)(4)(v) In addition to the requirements of paragraph (d)(4)(ii) of this section, the denominator(s) for the following monitors of output components (except those operated only at engine start-up and subject to the requirements of paragraph (d)(4)(iv) of this section, may be incremented if and only if the component is commanded to function (e.g., commanded “on”, “opened”, “closed”, “locked”) on two or more occasions during the drive cycle or for a time greater than or equal to 10 seconds, whichever occurs first:

(d)(4)(v)(A) Variable valve timing and/or control system (paragraph (g)(10) or (h)(9) of this section)

(d)(4)(v)(B) “Other emission control systems” (paragraph (i)(4) of this section)

(d)(4)(v)(C) Comprehensive component output component (paragraph (i)(3) of this section) (e.g., turbocharger waste-gates, variable length manifold runners).

(d)(4)(vi) For monitors of the following components, the manufacturer may use alternative or additional criteria for incrementing the denominator to that set forth in paragraph (d)(4)(ii) of this section. To do so, the alternative criteria must be based on equivalence to the criteria of paragraph (d)(4)(ii) of this section in measuring the frequency of monitor operation relative to the amount of engine operation:

(d)(4)(vi)(A) Engine cooling system input components (paragraph (i)(1) of this section)

(d)(4)(vi)(B) “Other emission control systems” (paragraph (i)(4) of this section)

(d)(4)(vi)(C) Comprehensive component input components that require extended monitoring evaluation (paragraph (i)(3) of this section) (e.g., stuck fuel level sensor rationality).

(d)(4)(vii) For monitors of the following components or other emission controls that experience infrequent regeneration events, the manufacturer may use alternative or additional criteria for incrementing the denominator to that set forth in paragraph (d)(4)(ii) of this section. To do so, the alternative criteria must be based on equivalence to the criteria of paragraph (d)(4)(ii) of this section in measuring the frequency of monitor operation relative to the amount of engine operation:

(d)(4)(vii)(A) Oxidation catalyst (paragraph (g)(5) of this section)

(d)(4)(vii)(B) DPF (paragraph (g)(8) of this section).

(d)(4)(viii) For hybrids that employ alternative engine start hardware or strategies (e.g., integrated starter and generators), or alternative fuel vehicles (e.g., dedicated, bi-fuel, or dual-fuel applications), the manufacturer may use alternative criteria for incrementing the denominator to that set forth in paragraph (d)(4)(ii) of this section. In general, the Administrator will not approve alternative criteria for those hybrids that employ engine shut off only at or near idle and/or vehicle stop conditions. To use alternative criteria, the alternative criteria must be based on the equivalence to the criteria of paragraph (d)(4)(ii) of this section in measuring the amount of vehicle operation relative to the measure of conventional vehicle operation.

(d)(5) *Disablement of numerators and denominators*.

(d)(5)(i) Within 10 seconds of detecting a malfunction (i.e., a pending or a MIL-on DTC has been stored) that disables a monitor for which the monitoring conditions in paragraph (d) of this section must be met, the OBD system must stop incrementing the numerator and denominator for any monitor that may be disabled as a consequence of the detected malfunction. Within 10 seconds of the time at which the malfunction is no longer being detected (e.g., the pending DTC is erased through OBD system self-clearing or through a scan tool command), incrementing of all applicable numerators and denominators must resume.

(d)(5)(ii) Within 10 seconds of the start of a power take-off unit (e.g., dump bed, snow plow blade, or aerial bucket, etc.) that disables a monitor for which the monitoring conditions in paragraph (d) of this section must be met, the OBD system must stop incrementing the numerator and denominator for any monitor that may be disabled as a consequence of power take-off operation. Within 10 seconds of the time at which the power take-off operation ends, incrementing of all applicable numerators and denominators must resume.

(d)(5)(iii) Within 10 seconds of detecting a malfunction (i.e., a pending or a MIL-on DTC has been stored) of any component used to determine if the criteria of paragraphs (d)(4)(ii) and (d)(4)(iii) of this section are satisfied, the OBD system must stop incrementing all applicable numerators and denominators. Within 10 seconds of the time at which the malfunction is no longer being detected (e.g., the pending DTC is erased through OBD system self-clearing or through a scan tool command), incrementing of all applicable numerators and denominators must resume.

(e) Standardized tracking and reporting of in-use monitor performance

(e) *Standardized tracking and reporting of in-use monitor performance*.

(e)(1) *General*. For monitors required to track and report in-use monitor performance according to paragraph (d) of this section, the performance data must be tracked and reported in accordance with the specifications in paragraphs (d)(2), (e), and (k)(5) of this section. The OBD system must separately report an in-use monitor performance numerator and denominator for each of the following components:

(e)(1)(i) For diesel engines, NMHC catalyst bank 1, NMHC catalyst bank 2, NOx catalyst bank 1, NOx catalyst bank 2, exhaust gas sensor bank 1, exhaust gas sensor bank 2, EGR/VVT

system, DPF, boost pressure control system, and NOx adsorber. The OBD system must also report a general denominator and an ignition cycle counter in the standardized format specified in paragraphs (e)(5), (e)(6), and (k)(5) of this section.

(e)(1)(ii) For gasoline engines, catalyst bank 1, catalyst bank 2, exhaust gas sensor bank 1, exhaust gas sensor bank 2, evaporative leak detection system, EGR/VVT system, and secondary air system. The OBD system must also report a general denominator and an ignition cycle counter in the standardized format specified in paragraphs (e)(5), (e)(6), and (k)(5) of this section.

(e)(1)(iii) For specific components or systems that have multiple monitors that are required to be reported under paragraphs (g) and (h) of this section (e.g., exhaust gas sensor bank 1 may have multiple monitors for sensor response or other sensor characteristics), the OBD system must separately track numerators and denominators for each of the specific monitors and report only the corresponding numerator and denominator for the specific monitor that has the lowest numerical ratio. If two or more specific monitors have identical ratios, the corresponding numerator and denominator for the specific monitor that has the highest denominator must be reported for the specific component.

(e)(2) *Numerator*.

(e)(2)(i) The OBD system must report a separate numerator for each of the applicable components listed in paragraph (e)(1) of this section.

(e)(2)(ii) The numerator(s) must be reported in accordance with the specifications in paragraph (k)(5)(ii)of this section.

(e)(3) *Denominator*.

(e)(3)(i) The OBD system must report a separate denominator for each of the applicable components listed in paragraph (e)(1) of this section.

(e)(3)(ii) The denominator(s) must be reported in accordance with the specifications in paragraph (k)(5)(ii)of this section.

(e)(4) *Monitor performance ratio*. For purposes of determining which corresponding numerator and denominator to report as required in paragraph (e)(1)(iii) of this section, the ratio must be calculated in accordance with the specifications in paragraph (k)(5)(iii) of this section.

(e)(5) *Ignition cycle counter*.

(e)(5)(i) The ignition cycle counter is defined as a counter that indicates the number of ignition cycles a vehicle has experienced according to the specifications of paragraph (e)(5)(ii)(B) of this section. The ignition cycle counter must be reported in accordance with the specifications in paragraph (k)(5)(ii)of this section.

(e)(5)(ii) The ignition cycle counter must be incremented as follows:

(e)(5)(ii)(A) The ignition cycle counter, when incremented, must be incremented by an integer of one. The ignition cycle counter shall not be incremented more than once per ignition cycle.

(e)(5)(ii)(B) The ignition cycle counter must be incremented within 10 seconds if and only if the engine exceeds an engine speed of 50 to 150 rpm below the normal, warmed-up idle speed (as determined in the drive position for engines paired with an automatic transmission) for at least two seconds plus or minus one second.

(e)(5)(iii) Within 10 seconds of detecting a malfunction (i.e., a pending or a MIL-on DTC has been stored) of any component used to determine if the criteria in paragraph (e)(5)(ii)(B) of this section are satisfied (i.e., engine speed or time of operation), the OBD system must stop incrementing the ignition cycle counter. Incrementing of the ignition cycle counter shall not be stopped for any other condition. Within 10 seconds of the time at which the malfunction is no longer being detected (e.g., the pending DTC is erased through OBD system self-clearing or through a scan tool command), incrementing of the ignition cycle counter must resume.

(e)(6) *General denominator*.

(e)(6)(i) The general denominator is defined as a measure of the number of times an engine has been operated according to the specifications of paragraph (e)(6)(ii)(B) of this section. The general denominator must be reported in accordance with the specifications in paragraph (k)(5)(ii)of this section.

(e)(6)(ii) The general denominator must be incremented as follows:

(e)(6)(ii)(A) The general denominator, when incremented, must be incremented by an integer of one. The general denominator shall not be incremented more than once per drive cycle.

(e)(6)(ii)(B) The general denominator must be incremented within 10 seconds if and only if the criteria identified in paragraph (d)(4)(ii) of this section are satisfied on a single drive cycle.

(e)(6)(ii)(C) Within 10 seconds of detecting a malfunction (i.e., a pending or a MIL-on DTC has been stored) of any component used to determine if the criteria in paragraph (d)(4)(ii) of this section are satisfied (i.e., vehicle speed/load, ambient temperature, elevation, idle operation, or time of operation), the OBD system must stop incrementing the general denominator. Incrementing of the general denominator shall not be stopped for any other condition (e.g., the disablement criteria in paragraphs (d)(5)(i) and (d)(5)(ii) of this section shall not disable the general denominator). Within 10 seconds of the time at which the malfunction is no longer being detected (e.g., the pending DTC is erased through OBD system self-clearing or through a scan tool command), incrementing of the general denominator must resume.

(f) Malfunction criteria determination

(f) *Malfunction criteria determination*.

(f)(1) In determining the malfunction criteria for the diesel engine monitors required under paragraphs (g) and (i) of this section that are required to indicate a malfunction before emissions exceed an emission threshold based on any applicable standard, the manufacturer must:

(f)(1)(i) Use the emission test cycle and standard (i.e., the transient FTP or the supplemental emissions test (SET)) determined by the manufacturer to be more stringent (i.e., to result in higher emissions with the same level of monitored component malfunction). The manufacturer must use data and/or engineering analysis to determine the test cycle and standard that is more stringent.

(f)(1)(ii) Identify in the certification documentation required under paragraph (m) of this section, the test cycle and standard determined by the manufacturer to be the most stringent for each applicable monitor.

(f)(1)(iii) If the Administrator reasonably believes that a manufacturer has determined incorrectly the test cycle and standard that is most stringent, the manufacturer must be able to provide emission data and/or engineering analysis supporting their choice of test cycle and standard.

(f)(2) On engines equipped with emission controls that experience infrequent regeneration events, a manufacturer must adjust the emission test results that are used to determine the malfunction criteria for monitors that are required to indicate a malfunction before emissions exceed a certain emission threshold. For each such monitor, the manufacturer must adjust the emission result as done in accordance with the provisions of section 86.004-28(i) with the component for which the malfunction criteria are being established having been deteriorated to the malfunction threshold. The adjusted emission value must be used for purposes of determining whether or not the applicable emission threshold is exceeded.

(f)(2)(i) For purposes of this paragraph (f)(2) of this section, regeneration means an event, by design, during which emissions levels change while the emission control performance is being restored.

(f)(2)(ii) For purposes of this paragraph (f)(2) of this section, infrequent means having an expected frequency of less than once per transient FTP cycle.

(f)(3) For gasoline engines, rather than meeting the malfunction criteria specified under paragraphs (h) and (i) of this section, the manufacturer may request approval to use an OBD system certified to the requirements of §86.010-17. To do so, the manufacturer must demonstrate use of good engineering judgment in determining equivalent malfunction detection criteria to those required in this section.

(g) Monitoring requirements for diesel-fueled/CI engines

(g) *OBD monitoring requirements for diesel-fueled/compression-ignition engines*. The following table shows the thresholds at which point certain components or systems, as specified in this paragraph (g), are considered malfunctioning.

Table 1. OBD Emissions Thresholds for Diesel-Fueled/Compression-Ignition Engines meant for Placement in Applications Greater than 14,000 Pounds GVWR (g/bhp-hr)

Component	§86.010-18 reference	NMHC	CO	NOx	PM
NMHC catalyst system	(g)(5)	2.5x	--	--	--
NOx aftertreatment system	(g)(6) (g)(7)	--	--	+0.3	--
Diesel particulate filter (DPF) system	(g)(8)	2.5x	--	--	0.05/+0.04
Air-fuel ratio sensors upstream of aftertreatment devices	(g)(9)	2.5x	2.5x	+0.3	0.03/+0.02
Air-fuel ratio sensors downstream of aftertreatment devices	(g)(9)	2.5x	--	+0.3	0.05/+0.04
NOx sensors	(g)(9)	--	--	+0.3	0.05/+0.04
"Other monitors" with emissions thresholds	(g)(1) (g)(3) (g)(4) (g)(10)	2.5x	2.5x	+0.3	0.03/+0.02

Notes: FEL=Family Emissions Limit; 2.5x std means a multiple of 2.5 times the applicable emissions standard; +0.3 means the standard or FEL plus 0.3; 0.05/+0.04 means an absolute level of 0.05 or an additive level of the standard or FEL plus 0.04, whilchever level is higher; these emissions thresholds apply to the monitoring requirements of paragraph (g) of this section 86.010-18.

(g)(1) Fuel system

(g)(1) *Fuel system monitoring*.

(g)(1)(i) *General*. The OBD system must monitor the fuel delivery system to verify that it is functioning properly. The individual electronic components (e.g., actuators, valves, sensors, pumps) that are used in the fuel system and are not specifically addressed in this paragraph (g)(1) must be monitored in accordance with the requirements of paragraph (i)(3)of this section.

(g)(1)(ii) *Fuel system malfunction criteria*.

(g)(1)(ii)(A) *Fuel system pressure control*. The OBD system must monitor the fuel system's ability to control to the desired fuel pressure. This monitoring must be done continuously unless new hardware has to be added, in which case the monitoring must be done at least once per drive cycle. The OBD system must detect a malfunction of the fuel system's pressure control system when the pressure control system is unable to maintain an engine's emissions at or below the emissions thresholds for "other monitors" as shown in Table 1 of this paragraph (g). For engines in which no failure or deterioration of the fuel system pressure control could result in an engine's emissions exceeding the applicable emissions thresholds, the OBD system must detect a malfunction when the system has reached its control limits such that the commanded fuel system pressure cannot be delivered.

(g)(1)(ii)(B) *Fuel system injection quantity*. The OBD system must detect a malfunction of the fuel injection system when the system is unable to deliver the commanded quantity of fuel necessary to maintain an engine's emissions at or below the emissions thresholds for "other monitors" as shown in Table 1 of this paragraph (g). For engines in which no failure or deterioration of the fuel injection quantity could result in an engine's emissions exceeding the applicable emissions thresholds, the OBD system must detect a malfunction when the system has reached its control limits such that the commanded fuel quantity cannot be delivered.

(g)(1)(ii)(C) *Fuel system injection timing*. The OBD system must detect a malfunction of the fuel injection system when the system is unable to deliver fuel at the proper crank angle/timing (e.g., injection timing too advanced or too retarded) necessary to maintain an engine's emissions at or below the emissions thresholds for "other monitors" as shown in Table 1 of this paragraph (g). For engines in which no failure or deterioration of the fuel injection timing could result in an

engine's emissions exceeding the applicable emissions thresholds, the OBD system must detect a malfunction when the system has reached its control limits such that the commanded fuel injection timing cannot be achieved.

(g)(1)(ii)(D) *Fuel system feedback control*. See paragraph (i)(6)of this section.

(g)(1)(iii) *Fuel system monitoring conditions*.

(g)(1)(iii)(A) The OBD system must monitor continuously for malfunctions identified in paragraphs (g)(1)(ii)(A) and (g)(1)(ii)(D) of this section.

(g)(1)(iii)(B) The manufacturer must define the monitoring conditions for malfunctions identified in paragraphs (g)(1)(ii)(B) and (g)(1)(ii)(C) in accordance with paragraphs (c) and (d) of this section.

(g)(1)(iv) *Fuel system MIL activation and DTC storage*. The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(g)(2) Engine misfire

(g)(2) *Engine misfire monitoring*.

(g)(2)(i) *General*. The OBD system must monitor the engine for misfire causing excess emissions.

(g)(2)(ii) *Engine misfire malfunction criteria*. The OBD system must be capable of detecting misfire occurring in one or more cylinders. To the extent possible without adding hardware for this specific purpose, the OBD system must also identify the specific misfiring cylinder. If more than one cylinder is misfiring continuously, a separate DTC must be stored indicating that multiple cylinders are misfiring. When identifying multiple cylinder misfire, the OBD system is not required to identify individually through separate DTCs each of the continuously misfiring cylinders.

(g)(2)(iii) *Engine misfire monitoring conditions*.

(g)(2)(iii)(A) The OBD system must monitor for engine misfire during engine idle conditions at least once per drive cycle in which the monitoring conditions for misfire are met. The manufacturer must be able to demonstrate via engineering analysis and/or data that the self-defined monitoring conditions: are technically necessary to ensure robust detection of malfunctions (e.g., avoid false passes and false detection of malfunctions); require no more than 1000 cumulative engine revolutions; and, do not require any single continuous idle operation of more than 15 seconds to make a determination that a malfunction is present (e.g., a decision can be made with data gathered during several idle operations of 15 seconds or less); or, satisfy the requirements of paragraph (c) of this section with alternative engine operating conditions.

(g)(2)(iii)(B) Manufacturers may employ alternative monitoring conditions (e.g., off-idle) provided the manufacturer is able to demonstrate that the alternative monitoring ensure equivalent robust detection of malfunctions and equivalent timeliness in detection of malfunctions.

(g)(2)(iv) *Engine misfire MIL activation and DTC storage*. The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(g)(3) EGR system

(g)(3) *EGR system monitoring*.

(g)(3)(i) *General*. The OBD system must monitor the EGR system on engines so equipped for low flow rate, high flow rate, and slow response malfunctions. For engines equipped with EGR coolers (e.g., heat exchangers), the OBD system must monitor the cooler for insufficient cooling malfunctions. The individual electronic components (e.g., actuators, valves, sensors) that are used in the EGR system must be monitored in accordance with the comprehensive component requirements in paragraph (i)(3) of this section.

(g)(3)(ii) *EGR system malfunction criteria*.

(g)(3)(ii)(A) *EGR low flow*. The OBD system must detect a malfunction of the EGR system prior to a decrease from the manufacturer's specified EGR flow rate that would cause an engine's emissions to exceed the emissions thresholds for "other monitors" as shown in Table 1 of this paragraph (g). For engines in which no failure or deterioration of the EGR system that causes a decrease in flow could result in an engine's emissions exceeding the applicable emissions thresholds, the OBD system must detect a malfunction when the system has reached its control limits such that it cannot increase EGR flow to achieve the commanded flow rate.

(g)(3)(ii)(B) *EGR high flow*. The OBD system must detect a malfunction of the EGR system, including a leaking EGR valve (i.e., exhaust gas flowing through the valve when the valve is

commanded closed) prior to an increase from the manufacturer's specified EGR flow rate that would cause an engine's emissions to exceed the emissions thresholds for "other monitors" as shown in Table 1 of this paragraph (g). For engines in which no failure or deterioration of the EGR system that causes an increase in flow could result in an engine's emissions exceeding the applicable emissions thresholds, the OBD system must detect a malfunction when the system has reached its control limits such that it cannot reduce EGR flow to achieve the commanded flow rate.

(g)(3)(ii)(C) *EGR slow response*. The OBD system must detect a malfunction of the EGR system prior to any failure or deterioration in the capability of the EGR system to achieve the commanded flow rate within a manufacturer-specified time that would cause an engine's emissions to exceed the emissions thresholds for "other monitors" as shown in Table 1 of this paragraph (g). The OBD system must monitor both the capability of the EGR system to respond to a commanded increase in flow and the capability of the EGR system to respond to a commanded decrease in flow.

(g)(3)(ii)(D) *EGR system feedback control*. See paragraph (i)(6)of this section.

(g)(3)(ii)(E) *EGR cooler performance*. The OBD system must detect a malfunction of the EGR cooler prior to a reduction from the manufacturer's specified cooling performance that would cause an engine's emissions to exceed the emissions thresholds for "other monitors" as shown in Table 1 of this paragraph (g). For engines in which no failure or deterioration of the EGR cooler could result in an engine's emissions exceeding the applicable emissions thresholds, the OBD system must detect a malfunction when the system has no detectable amount of EGR cooling.

(g)(3)(iii) *EGR system monitoring conditions*.

(g)(3)(iii)(A) The OBD system must monitor continuously for malfunctions identified in paragraphs (g)(3)(ii)(A), (g)(3)(ii)(B), and (g)(3)(ii)(D) of this section.

(g)(3)(iii)(B) The manufacturer must define the monitoring conditions for malfunctions identified in paragraph (g)(3)(ii)(C) in accordance with paragraphs (c) and (d) of this section, with the exception that monitoring must occur every time the monitoring conditions are met during the drive cycle rather than once per drive cycle as required in paragraph (c)(2) of this section. For purposes of tracking and reporting as required in paragraph (d)(1) of this section, all monitors used to detect malfunctions identified in paragraph (g)(3)(ii)(C) of this section must be tracked separately but reported as a single set of values as specified in paragraph (e)(1)(iii) of this section.

(g)(3)(iii)(C) The manufacturer must define the monitoring conditions for malfunctions identified in paragraph (g)(3)(ii)(E) of this section in accordance with paragraphs (c) and (d) of this section. For purposes of tracking and reporting as required in paragraph (d)(1) of this section, all monitors used to detect malfunctions identified in paragraph (g)(3)(ii)(E) of this section must be tracked separately but reported as a single set of values as specified in paragraph (e)(1)(iii) of this section.

(g)(3)(iii)(D) The manufacturer may request Administrator approval to disable temporarily the EGR system monitor(s) under specific conditions (e.g., when freezing may affect performance of the system) provided the manufacturer is able to demonstrate via data or engineering analysis that a reliable monitor cannot be run when these conditions exist.

(g)(3)(iv) *EGR system MIL activation and DTC storage*. The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(g)(4) Turbo boost control system

(g)(4) *Turbo boost control system monitoring*.

(g)(4)(i) *General*. The OBD system must monitor the boost pressure control system (e.g., turbocharger) on engines so equipped for under and over boost malfunctions. For engines equipped with variable geometry turbochargers (VGT), the OBD system must monitor the VGT system for slow response malfunctions. For engines equipped with charge air cooler systems, the OBD system must monitor the charge air cooler system for cooling system performance malfunctions. The individual electronic components (e.g., actuators, valves, sensors) that are used in the boost pressure control system must be monitored in accordance with the comprehensive component requirements in paragraph (i)(3) of this section.

(g)(4)(ii) *Turbo boost control system malfunction criteria*.

(g)(4)(ii)(A) *Turbo underboost*. The OBD system must detect a malfunction of the boost pressure control system prior to a decrease from the manufacturer's commanded boost pressure that would cause an engine's emissions to exceed the emissions thresholds for "other monitors" as shown in Table 1 of this paragraph (g). For engines in which no failure or deterioration of the boost pressure control system that causes a decrease in boost could result in an engine's emissions exceeding the applicable emissions thresholds, the OBD system must detect a malfunction when the system has reached its control limits such that it cannot increase boost to achieve the commanded boost pressure.

(g)(4)(ii)(B) *Turbo overboost*. The OBD system must detect a malfunction of the boost pressure control system prior to an increase from the manufacturer's commanded boost pressure that would cause an engine's emissions to exceed the emissions thresholds for "other monitors" as shown in Table 1 of this paragraph (g). For engines in which no failure or deterioration of the boost pressure control system that causes an increase in boost could result in an engine's emissions exceeding the applicable emissions thresholds, the OBD system must detect a malfunction when the system has reached its control limits such that it cannot decrease boost to achieve the commanded boost pressure.

(g)(4)(ii)(C) *VGT slow response*. The OBD system must detect a malfunction prior to any failure or deterioration in the capability of the VGT system to achieve the commanded turbocharger geometry within a manufacturer-specified time that would cause an engine's emissions to exceed the emissions thresholds for "other monitors" as shown in Table 1 of this paragraph (g). For engines in which no failure or deterioration of the VGT system response could result in an engine's emissions exceeding the applicable emissions thresholds, the OBD system must detect a malfunction of the VGT system when proper functional response of the system to computer commands does not occur.

(g)(4)(ii)(D) *Turbo boost feedback control*. See paragraph (i)(6)of this section.

(g)(4)(ii)(E) *Charge air undercooling*. The OBD system must detect a malfunction of the charge air cooling system prior to a decrease from the manufacturer's specified cooling rate that would cause an engine's emissions to exceed the emissions thresholds for "other monitors" as shown in Table 1 of this paragraph (g). For engines in which no failure or deterioration of the charge air cooling system that causes a decrease in cooling performance could result in an engine's emissions exceeding the applicable emissions thresholds, the OBD system must detect a malfunction when the system has no detectable amount of charge air cooling.

(g)(4)(iii) *Turbo boost monitoring conditions*.

(g)(4)(iii)(A) The OBD system must monitor continuously for malfunctions identified in paragraphs (g)(4)(ii)(A), (g)(4)(ii)(B), and (g)(4)(ii)(D) of this section.

(g)(4)(iii)(B) The manufacturer must define the monitoring conditions for malfunctions identified in paragraph (g)(4)(ii)(C) of this section in accordance with paragraphs (c) and (d) of this section, with the exception that monitoring must occur every time the monitoring conditions are met during the drive cycle rather than once per drive cycle as required in paragraph (c)(2) of this section. For purposes of tracking and reporting as required in paragraph (d)(1) of this section, all monitors used to detect malfunctions identified in paragraph (g)(4)(ii)(C) of this section must be tracked separately but reported as a single set of values as specified in paragraph (e)(1)(iii) of this section.

(g)(4)(iii)(C) The manufacturer must define the monitoring conditions for malfunctions identified in paragraph (g)(4)(ii)(E) of this section in accordance with paragraphs (c) and (d) of this section. For purposes of tracking and reporting as required in paragraph (d)(1) of this section, all monitors used to detect malfunctions identified in paragraph (g)(4)(ii)(E) of this section must be tracked separately but reported as a single set of values as specified in paragraph (e)(1)(iii) of this section.

(g)(4)(iv) *Turbo boost system MIL activation and DTC storage*. The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(g)(5) NMHC catalyst

(g)(5) *NMHC converting catalyst monitoring*.

(g)(5)(i) *General*. The OBD system must monitor the NMHC converting catalyst(s) for proper NMHC conversion capability. For engines equipped with catalyzed diesel particulate filter(s)

(DPF) that convert NMHC emissions, the catalyst function of the DPF must be monitored in accordance with the DPF requirements of paragraph (g)(8) of this section. For purposes of this paragraph (g)(5), each catalyst that converts NMHC must be monitored either individually or in combination with others.

(g)(5)(ii) *NMHC converting catalyst malfunction criteria*.

(g)(5)(ii)(A) *NMHC converting catalyst conversion efficiency*. The OBD system must detect a catalyst malfunction when the catalyst conversion capability decreases to the point that NMHC emissions exceed the emissions thresholds for the NMHC catalyst system as shown in Table 1 of this paragraph (g). If no failure or deterioration of the catalyst NMHC conversion capability could result in an engine's NMHC emissions exceeding the applicable emissions thresholds, the OBD system must detect a malfunction when the catalyst has no detectable amount of NMHC conversion capability.

(g)(5)(ii)(B) *NMHC converting catalyst aftertreatment assistance functions*. For catalysts used to generate an exotherm to assist DPF regeneration, the OBD system must detect a malfunction when the catalyst is unable to generate a sufficient exotherm to achieve DPF regeneration. For catalysts used to generate a feedgas constituency to assist selective catalytic reduction (SCR) systems (e.g., to increase NO_2 concentration upstream of an SCR system), the OBD system must detect a malfunction when the catalyst is unable to generate the necessary feedgas constituents for proper SCR system operation. For catalysts located downstream of a DPF and used to convert NMHC emissions during DPF regeneration, the OBD system must detect a malfunction when the catalyst has no detectable amount of NMHC conversion capability.

(g)(5)(iii) *NMHC converting catalyst monitoring conditions*. The manufacturer must define the monitoring conditions for malfunctions identified in paragraphs (g)(5)(ii)(A) and (g)(5)(ii)(B) of this section in accordance with paragraphs (c) and (d) of this section. For purposes of tracking and reporting as required in paragraph (d)(1) of this section, all monitors used to detect malfunctions identified in paragraphs (g)(5)(ii)(A) and (g)(5)(ii)(B) of this section must be tracked separately but reported as a single set of values as specified in paragraph (e)(1)(iii) of this section.

(g)(5)(iv) *NMHC converting catalyst MIL activation and DTC storage*. The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section. The monitoring method for the NMHC converting catalyst(s) must be capable of detecting all instances, except diagnostic self-clearing, when a catalyst DTC has been erased but the catalyst has not been replaced (e.g., catalyst over-temperature histogram approaches are not acceptable).

(g)(6) SCR & lean NOx catalyst

(g)(6) *Selective catalytic reduction (SCR) and lean NOx catalyst monitoring*.

(g)(6)(i) *General*. The OBD system must monitor the SCR and/or the lean NOx converting catalyst(s) for proper conversion capability. For engines equipped with SCR systems or other catalyst systems that use an active/intrusive reductant injection (e.g., active lean NOx catalysts that use diesel fuel post-injection or in-exhaust injection), the OBD system must monitor the active/intrusive reductant injection system for proper performance. The individual electronic components (e.g., actuators, valves, sensors, heaters, pumps) in the active/intrusive reductant injection system must be monitored in accordance with the comprehensive component requirements in paragraph (i)(3) of this section. For purposes of this paragraph (g)(6), each catalyst that converts NOx must be monitored either individually or in combination with others.

(g)(6)(ii) *SCR and lean NOx catalyst malfunction criteria*.

(g)(6)(ii)(A) *SCR and lean NOx catalyst conversion efficiency*. The OBD system must detect a catalyst malfunction when the catalyst conversion capability decreases to the point that would cause an engine's emissions to exceed the emissions thresholds for NOx aftertreatment systems as shown in Table 1 of this paragraph (g). If no failure or deterioration of the catalyst NOx conversion capability could result in an engine's emissions exceeding any of the applicable emissions thresholds, the OBD system must detect a malfunction when the catalyst has no detectable amount of NOx conversion capability.

(g)(6)(ii)(B) *SCR and lean NOx catalyst active/intrusive reductant delivery performance*. The OBD system must detect a malfunction prior to any failure or deterioration of the system to properly regulate reductant delivery (e.g., urea injection, separate injector fuel injection, post injection of fuel, air assisted injection/mixing) that would cause an engine's emissions to exceed

any of the applicable emissions thresholds for NOx aftertreatment systems as shown in Table 1 of this paragraph (g). If no failure or deterioration of the reductant delivery system could result in an engine's emissions exceeding any of the applicable thresholds, the OBD system must detect a malfunction when the system has reached its control limits such that it is no longer able to deliver the desired quantity of reductant.

(g)(6)(ii)(C) *SCR and lean NOx catalyst active/intrusive reductant quantity*. If the SCR or lean NOx catalyst system uses a reductant other than the fuel used for the engine, or uses a reservoir/tank for the reductant that is separate from the fuel tank used for the engine, the OBD system must detect a malfunction when there is no longer sufficient reductant available (e.g., the reductant tank is empty).

(g)(6)(ii)(D) *SCR and lean NOx catalyst active/intrusive reductant quality*. If the SCR or lean NOx catalyst system uses a reservoir/tank for the reductant that is separate from the fuel tank used for the engine, the OBD system must detect a malfunction when an improper reductant is used in the reductant reservoir/tank (e.g., the reductant tank is filled with something other than the reductant).

(g)(6)(ii)(E) *SCR and lean NOx catalyst active/intrusive reductant feedback control*. See paragraph (i)(6)of this section.

(g)(6)(iii) *SCR and lean NOx catalyst monitoring conditions*.

(g)(6)(iii)(A) The manufacturers must define the monitoring conditions for malfunctions identified in paragraphs (g)(6)(ii)(A) and (g)(6)(ii)(D)of this section in accordance with paragraphs (c) and (d) of this section. For purposes of tracking and reporting as required in paragraph (d)(1) of this section, all monitors used to detect malfunctions identified in paragraph (g)(6)(ii)(A) of this section must be tracked separately but reported as a single set of values as specified in paragraph (e)(1)(iii) of this section.

(g)(6)(iii)(B) The OBD system must monitor continuously for malfunctions identified in paragraphs (g)(6)(ii)(B), (g)(6)(ii)(C), and (g)(6)(ii)(E) of this section.

(g)(6)(iv) *SCR and lean NOx catalyst MIL activation and DTC storage*.

(g)(6)(iv)(A) For malfunctions identified in paragraph (g)(6)(ii)(A) of this section, the MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(g)(6)(iv)(B) For malfunctions identified in paragraphs (g)(6)(ii)(B), (g)(6)(ii)(C), and (g)(6)(ii)(D) of this section, the manufacturer may delay activating the MIL if the vehicle is equipped with an alternative indicator for notifying the vehicle operator of the malfunction. The alternative indicator must be of sufficient illumination and be located such that it is readily visible to the vehicle operator under all lighting conditions. If the vehicle is not equipped with such an alternative indicator and the OBD MIL activates, the MIL may be immediately deactivated and the corresponding DTC(s) erased once the OBD system has verified that the reductant tank has been refilled properly and the MIL has not been activated for any other malfunction. The Administrator may approve other strategies that provide equivalent assurance that a vehicle operator would be promptly notified and that corrective action would be taken.

(g)(6)(iv)(C) The monitoring method for the SCR and lean NOx catalyst(s) must be capable of detecting all instances, except diagnostic self-clearing, when a catalyst DTC(s) has been erased but the catalyst has not been replaced (e.g., catalyst over-temperature histogram approaches are not acceptable).

(g)(7) NOx adsorber system

(g)(7) *NOx adsorber system monitoring*.

(g)(7)(i) *General*. The OBD system must monitor the NOx adsorber on engines so-equipped for proper performance. For engines equipped with active/intrusive injection (e.g., in-exhaust fuel and/or air injection) to achieve desorption of the NOx adsorber, the OBD system must monitor the active/intrusive injection system for proper performance. The individual electronic components (e.g., injectors, valves, sensors) that are used in the active/intrusive injection system must be monitored in accordance with the comprehensive component requirements in paragraph (i)(3) of this section.

(g)(7)(ii) *NOx adsorber system malfunction criteria*.

(g)(7)(ii)(A) *NOx adsorber system capability*. The OBD system must detect a NOx adsorber malfunction when its capability (i.e., its combined adsorption and conversion capability)

decreases to the point that would cause an engine's NOx emissions to exceed the emissions thresholds for NOx aftertreatment systems as shown in Table 1 of this paragraph (g). If no failure or deterioration of the NOx adsorber capability could result in an engine's NOx emissions exceeding the applicable emissions thresholds, the OBD system must detect a malfunction when the system has no detectable amount of NOx adsorber capability.

(g)(7)(ii)(B) *NOx adsorber system active/intrusive reductant delivery performance*. For NOx adsorber systems that use active/intrusive injection (e.g., in-cylinder post fuel injection, in-exhaust air-assisted fuel injection) to achieve desorption of the NOx adsorber, the OBD system must detect a malfunction if any failure or deterioration of the injection system's ability to properly regulate injection causes the system to be unable to achieve desorption of the NOx adsorber.

(g)(7)(ii)(C) *NOx adsorber system feedback control*. Malfunction criteria for the NOx adsorber and the NOx adsorber active/instrusive reductant delivery system are contained in paragraph (i)(6)of this section.

(g)(7)(iii) *NOx adsorber system monitoring conditions*.

(g)(7)(iii)(A) The manufacturer must define the monitoring conditions for malfunctions identified in paragraph (g)(7)(ii)(A) of this section in accordance with paragraphs (c) and (d) of this section. For purposes of tracking and reporting as required in paragraph (d)(1) of this section, all monitors used to detect malfunctions identified in paragraph (g)(7)(ii)(A) of this section must be tracked separately but reported as a single set of values as specified in paragraph (e)(1)(iii) of this section.

(g)(7)(iii)(B) The OBD system must monitor continuously for malfunctions identified in paragraphs (g)(7)(ii)(B) and (g)(7)(ii)(C) of this section.

(g)(7)(iv) *NOx adsorber system MIL activation and DTC storage*. The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(g)(8) DPF system

(g)(8) *Diesel particulate filter (DPF) system monitoring*.

(g)(8)(i) *General*. The OBD system must monitor the DPF on engines so-equipped for proper performance. For engines equipped with active regeneration systems that use an active/intrusive injection (e.g., in-exhaust fuel injection, in-exhaust fuel/air burner), the OBD system must monitor the active/intrusive injection system for proper performance. The individual electronic components (e.g., injectors, valves, sensors) that are used in the active/intrusive injection system must be monitored in accordance with the comprehensive component requirements in paragraph (i)(3) of this section.

(g)(8)(ii) *DPF system malfunction criteria*.

(g)(8)(ii)(A) *DPF filtering performance*. The OBD system must detect a malfunction prior to a decrease in the PM filtering capability of the DPF (e.g., cracking, melting, etc.) that would cause an engine's PM emissions to exceed the emissions thresholds for DPF systems as shown in Table 1 of this paragraph (g). If no failure or deterioration of the PM filtering performance could result in an engine's PM emissions exceeding the applicable emissions thresholds, the OBD system must detect a malfunction when no detectable amount of PM filtering occurs.

(g)(8)(ii)(B) *DPF regeneration frequency*. The OBD system must detect a malfunction when the DPF regeneration frequency increases from (i.e., occurs more often than) the manufacturer's specified regeneration frequency to a level such that it would cause an engine's NMHC emissions to exceed the emissions threshold for DPF systems as shown in Table 1 of this paragraph (g). If no such regeneration frequency exists that could cause NMHC emissions to exceed the applicable emission threshold, the OBD system must detect a malfunction when the DPF regeneration frequency exceeds the manufacturer's specified design limits for allowable regeneration frequency.

(g)(8)(ii)(C) *DPF incomplete regeneration*. The OBD system must detect a regeneration malfunction when the DPF does not properly regenerate under manufacturer-defined conditions where regeneration is designed to occur.

(g)(8)(ii)(D) *DPF NMHC conversion*. For any DPF that serves to convert NMHC emissions, the OBD system must detect a malfunction when the NMHC conversion capability decreases to the point that NMHC emissions exceed the emissions threshold for DPF systems as shown in Table 1 of this paragraph (g). If no failure or deterioration of the NMHC conversion capability

could result in NMHC emissions exceeding the applicable threshold, the OBD system must detect a malfunction when the system has no detectable amount of NMHC conversion capability.

(g)(8)(ii)(E) *DPF missing substrate*. The OBD system must detect a malfunction if either the DPF substrate is completely destroyed, removed, or missing, or if the DPF assembly has been replaced with a muffler or straight pipe.

(g)(8)(ii)(F) *DPF system active/intrusive injection*. For DPF systems that use active/intrusive injection (e.g., in-cylinder post fuel injection, in-exhaust air-assisted fuel injection) to achieve regeneration of the DPF, the OBD system must detect a malfunction if any failure or deterioration of the injection system's ability to properly regulate injection causes the system to be unable to achieve regeneration of the DPF.

(g)(8)(ii)(G) *DPF regeneration feedback control*. See paragraph (i)(6) of this section.

(g)(8)(iii) *DPF monitoring conditions*. The manufacturer must define the monitoring conditions for malfunctions identified in paragraph (g)(8)(ii) of this section in accordance with paragraphs (c) and (d) of this section, with the exception that monitoring must occur every time the monitoring conditions are met during the drive cycle rather than once per drive cycle as required in paragraph (c)(2) of this section. For purposes of tracking and reporting as required in paragraph (d)(1) of this section, all monitors used to detect malfunctions identified in paragraph (g)(8)(ii) of this section must be tracked separately but reported as a single set of values as specified in paragraph (e)(1)(iii) of this section.

(g)(8)(iv) *DPF system MIL activation and DTC storage*. The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(g)(9) Exhaust gas sensors

(g)(9) *Exhaust gas sensor and sensor heater monitoring*.

(g)(9)(i) *General*. The OBD system must monitor for proper output signal, activity, response rate, and any other parameter that can affect emissions, all exhaust gas sensors (e.g., oxygen, air-fuel ratio, NOx) used for emission control system feedback (e.g., EGR control/feedback, SCR control/feedback, NOx adsorber control/feedback) and/or as a monitoring device. For engines equipped with heated exhaust gas sensors, the OBD system must monitor the heater for proper performance.

(g)(9)(ii) *Malfunction criteria for air-fuel ratio sensors located upstream of aftertreatment devices*.

(g)(9)(ii)(A) *Sensor performance*. The OBD system must detect a malfunction prior to any failure or deterioration of the sensor voltage, resistance, impedance, current, response rate, amplitude, offset, or other characteristic(s) that would cause an engine's emissions to exceed the emissions thresholds for "other monitors" as shown in Table 1 of this paragraph (g).

(g)(9)(ii)(B) *Circuit integrity*. The OBD system must detect malfunctions of the sensor related to a lack of circuit continuity or signal out-of-range values.

(g)(9)(ii)(C) *Feedback function*. The OBD system must detect a malfunction of the sensor if the emission control system (e.g., EGR, SCR, or NOx adsorber) is unable to use that sensor as a feedback input (e.g., causes limp-home or open-loop operation).

(g)(9)(ii)(D) *Monitoring function*. To the extent feasible, the OBD system must detect a malfunction of the sensor when the sensor output voltage, resistance, impedance, current, amplitude, activity, offset, or other characteristics are no longer sufficient for use as an OBD system monitoring device (e.g., for catalyst, EGR, SCR, or NOx adsorber monitoring).

(g)(9)(iii) *Malfunction criteria for air-fuel ratio sensors located downstream of aftertreatment devices*.

(g)(9)(iii)(A) *Sensor performance*. The OBD system must detect a malfunction prior to any failure or deterioration of the sensor voltage, resistance, impedance, current, response rate, amplitude, offset, or other characteristic(s) that would cause an engine's emissions to exceed the emissions thresholds for air-fuel ratio sensors downstream of aftertreatment devices as shown in Table 1 of this paragraph (g).

(g)(9)(iii)(B) *Circuit integrity*. The OBD system must detect malfunctions of the sensor related to a lack of circuit continuity or signal out-of-range values.

(g)(9)(iii)(C) *Feedback function*. The OBD system must detect a malfunction of the sensor if the emission control system (e.g., EGR, SCR, or NOx adsorber) is unable to use that sensor as a feedback input (e.g., causes limp-home or open-loop operation).

(g)(9)(iii)(D) *Monitoring function*. To the extent feasible, the OBD system must detect a malfunction of the sensor when the sensor output voltage, resistance, impedance, current, amplitude, activity, offset, or other characteristics are no longer sufficient for use as an OBD system monitoring device (e.g., for catalyst, EGR, SCR, or NOx adsorber monitoring).

(g)(9)(iv) *Malfunction criteria for NOx sensors*.

(g)(9)(iv)(A) *Sensor performance*. The OBD system must detect a malfunction prior to any failure or deterioration of the sensor voltage, resistance, impedance, current, response rate, amplitude, offset, or other characteristic(s) that would cause an engine's emissions to exceed the emissions thresholds for NOx sensors as shown in Table 1 of this paragraph (g).

(g)(9)(iv)(B) *Circuit integrity*. The OBD system must detect malfunctions of the sensor related to a lack of circuit continuity or signal out-of-range values.

(g)(9)(iv)(C) *Feedback function*. The OBD system must detect a malfunction of the sensor if the emission control system (e.g., EGR, SCR, or NOx adsorber) is unable to use that sensor as a feedback input (e.g., causes limp-home or open-loop operation).

(g)(9)(iv)(D) *Monitoring function*. To the extent feasible, the OBD system must detect a malfunction of the sensor when the sensor output voltage, resistance, impedance, current, amplitude, activity, offset, or other characteristics are no longer sufficient for use as an OBD system monitoring device (e.g., for catalyst, EGR, SCR, or NOx adsorber monitoring).

(g)(9)(v) *Malfunction criteria for other exhaust gas sensors.* For other exhaust gas sensors, the manufacturer must submit a monitoring plan to the Administrator for approval. The plan must include data and/or engineering evaluations that demonstrate that the monitoring plan is as reliable and effective as the monitoring required in paragraphs (g)(9)(ii) through (g)(9)(iv) of this section.

(g)(9)(vi) *Malfunction criteria for exhaust gas sensor heaters*.

(g)(9)(vi)(A) The OBD system must detect a malfunction of the heater performance when the current or voltage drop in the heater circuit is no longer within the manufacturer's specified limits for normal operation (i.e., within the criteria required to be met by the component vendor for heater circuit performance at high mileage). The manufacturer may use other malfunction criteria for heater performance malfunctions. To do so, the manufacturer must be able to demonstrate via data and/or an engineering evaluation that the monitor is reliable and robust.

(g)(9)(vi)(B) The OBD system must detect malfunctions of the heater circuit including open or short circuits that conflict with the commanded state of the heater (e.g., shorted to 12 Volts when commanded to 0 Volts (ground)).

(g)(9)(vii) *Monitoring conditions for exhaust gas sensors*.

(g)(9)(vii)(A) The manufacturer must define the monitoring conditions for malfunctions identified in paragraphs (g)(9)(ii)(A), (g)(9)(iii)(A), and (g)(9)(iv)(A) of this section (i.e., sensor performance) in accordance with paragraphs (c) and (d) of this section. For purposes of tracking and reporting as required in paragraph (d)(1) of this section, all monitors used to detect malfunctions identified in paragraphs (g)(9)(ii)(A), (g)(9)(iii)(A), and (g)(9)(iv)(A) of this section must be tracked separately but reported as a single set of values as specified in paragraph (e)(1)(iii) of this section.

(g)(9)(vii)(B) The manufacturer must define the monitoring conditions for malfunctions identified in paragraphs (g)(9)(ii)(D), (g)(9)(iii)(D), and (g)(9)(iv)(D) of this section (i.e., monitoring function) in accordance with paragraphs (c) and (d) of this section with the exception that monitoring must occur every time the monitoring conditions are met during the drive cycle rather than once per drive cycle as required in paragraph (c)(2) of this section.

(g)(9)(vii)(C) Except as provided for in paragraph (g)(9)(vii)(D)of this paragraph (g)(9), the OBD system must monitor continuously for malfunctions identified in paragraphs (g)(9)(ii)(B), (g)(9)(ii)(C), (g)(9)(iii)(B), (g)(9)(iii)(C), (g)(9)(iv)(B), and (g)(9)(iv)(C) (i.e., circuit integrity and feedback function).

(g)(9)(vii)(D) A manufacturer may request approval to disable continuous exhaust gas sensor monitoring when an exhaust gas sensor malfunction cannot be distinguished from other effects (e.g., disable monitoring for out-of-range on the low side during fuel cut conditions). To do

so, the manufacturer must demonstrate via data and/or engineering analyses that a properly functioning sensor cannot be distinguished from a malfunctioning sensor and that the disablement interval is limited only to that necessary for avoiding false malfunction detection.

(g)(9)(viii) Monitoring conditions for exhaust gas sensor heaters.

(g)(9)(viii)(A) The manufacturer must define monitoring conditions for malfunctions identified in paragraph (g)(9)(vi)(A) of this section (i.e., sensor heater performance) in accordance with paragraphs (c) and (d) of this section.

(g)(9)(viii)(B) The OBD system must monitor continuously for malfunctions identified in paragraph (g)(9)(vi)(B) of this section (i.e., circuit malfunctions).

(g)(9)(ix) *Exhaust gas sensor and sensor heater MIL activation and DTC storage.* The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(g)(10) VVT system

(g)(10) *Variable Valve Timing (VVT) system monitoring*.

(g)(10)(i) *General*. The OBD system must monitor the VVT system on engines so equipped for target error and slow response malfunctions. The individual electronic components (e.g., actuators, valves, sensors) that are used in the VVT system must be monitored in accordance with the comprehensive components requirements in paragraph (i)(3) of this section.

(g)(10)(ii) *VVT system malfunction criteria*.

(g)(10)(ii)(A) *VVT system target error*. The OBD system must detect a malfunction prior to any failure or deterioration in the capability of the VVT system to achieve the commanded valve timing and/or control within a crank angle and/or lift tolerance that would cause an engine's emissions to exceed the emission thresholds for "other monitors" as shown in Table 1 of this paragraph (g).

(g)(10)(ii)(B) *VVT slow response*. The OBD system must detect a malfunction prior to any failure or deterioration in the capability of the VVT system to achieve the commanded valve timing and/or control within a manufacturer-specified time that would cause an engine's emissions to exceed the emission thresholds for "other monitors" as shown in Table 1 of this paragraph (g).

(g)(10)(ii)(C) For engines in which no failure or deterioration of the VVT system could result in an engine's emissions exceeding the applicable emissions thresholds of paragraphs (g)(10)(ii)(A) and (g)(10)(ii)(B) of this section, the OBD system must detect a malfunction of the VVT system when proper functional response of the system to computer commands does not occur.

(g)(10)(iii) *VVT system monitoring conditions*. Manufacturers must define the monitoring conditions for VVT system malfunctions identified in paragraph (g)(10)(ii) of this section in accordance with paragraphs (c) and (d) of this section, with the exception that monitoring must occur every time the monitoring conditions are met during the drive cycle rather than once per drive cycle as required in paragraph (c)(2) of this section. For purposes of tracking and reporting as required in paragraph (d)(1) of this section, all monitors used to detect malfunctions identified in paragraph (g)(10)(ii) of this section must be tracked separately but reported as a single set of values as specified in paragraph (e)(1)(iii) of this section.

(g)(10)(iv) *VVT MIL activation and DTC storage*. The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(h) Monitoring requirements for gasoline-fueled/SI engines

(h) *OBD monitoring requirements for gasoline-fueled/spark-ignition engines*. The following table shows the thresholds at which point certain components or systems, as specified in this paragraph (h), are considered malfunctioning.

Table 2. OBD Emissions Thresholds for Gasoline-Fueled/Spark-Ignition Engines meant for Placement in Applications Greater than 14,000 Pounds GVWR (g/bhp-hr)

Component	NOx	NMHC	CO	§86.010-18 reference
Catalyst system	1.75x std	1.75x std	--	(h)(6)
Evaporative emissions control system	--	0.150 inch leak	--	(h)(7)
"Other monitors" with emissions thresholds	1.5x std	1.5x std	1.5x std	(h)(1), (h)(2) (h)(3), (h)(4) (h)(5), (h)(8) (h)(9)

Notes: 1.75x std means a multiple of 1.75 times the applicable emissions standard; these emissions thresholds apply to the monitoring requirements of paragraph (h) of this section 86.010-18; The evaporative emissions control system threshold is not, technically, an emissions threshold but rather a leak size that must be detected; nonetheless, for ease we refer to this as the threshold.

(h)(1) Fuel system

(h)(1) *Fuel system monitoring*.

(h)(1)(i) *General*. The OBD system must monitor the fuel delivery system to determine its ability to provide compliance with emission standards.

(h)(1)(ii) *Fuel system malfunction criteria*.

(h)(1)(ii)(A) The OBD system must detect a malfunction of the fuel delivery system (including feedback control based on a secondary oxygen sensor) when the fuel delivery system is unable to maintain an engine's emissions at or below the emissions thresholds for "other monitors" as shown in Table 2 of this paragraph (h).

(h)(1)(ii)(B) Except as provided for in paragraph (h)(1)(ii)(C) of this section, if the engine is equipped with adaptive feedback control, the OBD system must detect a malfunction when the adaptive feedback control has used up all of the adjustment allowed by the manufacturer.

(h)(1)(ii)(C) If the engine is equipped with feedback control that is based on a secondary oxygen (or equivalent) sensor, the OBD system is not required to detect a malfunction of the fuel system solely when the feedback control based on a secondary oxygen sensor has used up all of the adjustment allowed by the manufacturer. However, if a failure or deterioration results in engine emissions that exceed the emissions thresholds for "other monitors" as shown in Table 2 of this paragraph (h), the OBD system is required to detect a malfunction.

(h)(1)(ii)(D) The OBD system must detect a malfunction whenever the fuel control system fails to enter closed loop operation following engine start within a manufacturer specified time interval. The specified time interval must be supported by data and/or engineering analyses submitted by the manufacturer.

(h)(1)(ii)(E) The manufacturer may adjust the malfunction criteria and/or monitoring conditions to compensate for changes in altitude, for temporary introduction of large amounts of purge vapor, or for other similar identifiable operating conditions when such conditions occur.

(h)(1)(iii) *Fuel system monitoring conditions*. The fuel system must be monitored continuously for the presence of a malfunction.

(h)(1)(iv) *Fuel system MIL activation and DTC storage*.

(h)(1)(iv)(A) A pending DTC must be stored immediately upon the fuel system exceeding the malfunction criteria established in paragraph (h)(1)(ii) of this section.

(h)(1)(iv)(B) Except as provided for in paragraph (h)(1)(iv)(C) of this section, if a pending DTC is stored, the OBD system must activate the MIL immediately and store a MIL-on DTC if a malfunction is again detected during either the drive cycle immediately following storage of the pending DTC regardless of the conditions encountered during that drive cycle, or on the next drive cycle in which similar conditions are encountered to those that occurred when the pending DTC was stored. Similar conditions means engine conditions having an engine speed within 375 rpm, load conditions within 20 percent, and the same warm up status (i.e., cold or hot) as the engine conditions stored pursuant to paragraph (h)(1)(iv)(E) of this section. Other definitions of

similar conditions may be used but must result in comparable timeliness and reliability in detecting similar engine operation.

(h)(1)(iv)(C) The pending DTC may be erased at the end of the next drive cycle in which similar conditions have been encountered without having again exceeded the specified fuel system malfunction criteria. The pending DTC may also be erased if similar conditions are not encountered during the 80 drive cycles immediately following detection of the potential malfunction for which the pending DTC was stored.

(h)(1)(iv)(D) Storage of freeze frame conditions. The OBD system must store and erase freeze frame conditions either in conjunction with storing and erasing a pending DTC or in conjunction with storing and erasing a MIL-on DTC. Freeze frame information associated with a fuel system malfunction shall be stored in preference to freeze frame information required elsewhere in paragraphs (h) or (i) of this section.

(h)(1)(iv)(E) Storage of fuel system conditions for determining similar conditions of operation. The OBD must store the engine speed, load, and warm-up status present at the time it first detects a potential malfunction meeting the criteria of paragraph (h)(1)(ii) of this section and stores a pending DTC.

(h)(1)(iv)(F) Deactivating the MIL. The MIL may be extinguished after three sequential driving cycles in which similar conditions have been encountered without detecting a malfunction of the fuel system.

(h)(2) Engine misfire

(h)(2) *Engine misfire monitoring*.

(h)(2)(i) *General*.

(h)(2)(i)(A) The OBD system must monitor the engine for misfire causing catalyst damage and misfire causing excess emissions.

(h)(2)(i)(B) The OBD system must identify the specific cylinder that is misfiring. The manufacturer may store a general misfire DTC instead of a cylinder specific DTC under certain operating conditions. To do so, the manufacturer must submit data and/or engineering analyses that demonstrate that the misfiring cylinder cannot be identified reliably when the conditions occur.

(h)(2)(i)(C) If more than one cylinder is misfiring, a separate DTC must be stored to indicate that multiple cylinders are misfiring unless otherwise allowed by this paragraph (h)(2). When identifying multiple cylinder misfire, the OBD system is not required to also identify using separate DTCs each of the misfiring cylinders individually. If more than 90 percent of the detected misfires occur in a single cylinder, an appropriate DTC may be stored that indicates the specific misfiring cylinder rather than storing the multiple cylinder misfire DTC. If two or more cylinders individually have more than 10 percent of the total number of detected misfires, a multiple cylinder DTC must be stored.

(h)(2)(ii) *Engine misfire malfunction criteria*.

(h)(2)(ii)(A) *Misfire causing catalyst damage*. The manufacturer must determine the percentage of misfire evaluated in 200 revolution increments for each engine speed and load condition that would result in a temperature that causes catalyst damage. If this percentage of misfire is exceeded, it shall be considered a malfunction that must be detected. For every engine speed and load condition for which this percentage of misfire is determined to be lower than five percent, the manufacturer may set the malfunction criteria at five percent. The manufacturer may use a longer interval than 200 revolutions but only for determining, on a given drive cycle, the first misfire exceedance as provided in paragraph (h)(2)(iv)(A) of this section. To do so, the manufacturer must demonstrate that the interval is not so long that catalyst damage would occur prior to the interval being elapsed.

(h)(2)(ii)(B) *Misfire causing emissions to exceed the applicable thresholds*. The manufacturer must determine the percentage of misfire evaluated in 1000 revolution increments that would cause emissions from an emissions durability demonstration engine to exceed the emissions thresholds for “other monitors” as shown in Table 2 of this paragraph (h) if that percentage of misfire were present from the beginning of the test. If this percentage of misfire is exceeded, regardless of the pattern of misfire events (e.g., random, equally spaced, continuous), it shall be considered a malfunction that must be detected. To establish this percentage of misfire, the manufacturer must use misfire events occurring at equally spaced, complete engine cycle

intervals, across randomly selected cylinders throughout each 1000-revolution increment. If this percentage of misfire is determined to be lower than one percent, the manufacturer may set the malfunction criteria at one percent. The manufacturer may use a longer interval than 1000 revolutions. To do so, the manufacturer must demonstrate that the strategy would be equally effective and timely at detecting misfire.

(h)(2)(iii) *Engine misfire monitoring conditions*.

(h)(2)(iii)(A) The OBD system must monitor continuously for misfire under the following conditions: from no later than the end of the second crankshaft revolution after engine start; during the rise time and settling time for engine speed to reach the desired idle engine speed at engine start-up (i.e., “flare-up” and “flare-down”); and, under all positive torque engine speeds and load conditions except within the engine operating region bound by the positive torque line (i.e., engine load with the transmission in neutral), and the points represented by an engine speed of 3000 rpm with the engine load at the positive torque line and the redline engine speed with the engine’s manifold vacuum at four inches of mercury lower than that at the positive torque line. For this purpose, redline engine speed is defined as either the recommended maximum engine speed as displayed on the instrument panel tachometer, or the engine speed at which fuel shutoff occurs.

(h)(2)(iii)(B) If an OBD monitor cannot detect all misfire patterns under all required engine speed and load conditions as required by paragraph (h)(2)(iii)(A) of this section, the OBD system may still be acceptable. The Administrator will evaluate the following factors in making a determination: the magnitude of the region(s) in which misfire detection is limited; the degree to which misfire detection is limited in the region(s) (i.e., the probability of detection of misfire events); the frequency with which said region(s) are expected to be encountered in-use; the type of misfire patterns for which misfire detection is troublesome; and demonstration that the monitoring technology employed is not inherently incapable of detecting misfire under the required conditions (i.e., compliance can be achieved on other engines). The evaluation will be based on the following misfire patterns: equally spaced misfire occurring on randomly selected cylinders; single cylinder continuous misfire; and paired cylinder (cylinders firing at the same crank angle) continuous misfire.

(h)(2)(iii)(C) The manufacturer may use monitoring system that has reduced misfire detection capability during the portion of the first 1000 revolutions after engine start that a cold start emission reduction strategy is active that reduces engine torque (e.g., spark retard strategies). To do so, the manufacturer must demonstrate that the probability of detection is greater than or equal to 75 percent during the worst case condition (i.e., lowest generated torque) for a vehicle operated continuously at idle (park/neutral idle) on a cold start between 50 and 86 degrees Fahrenheit and that the technology cannot reliably detect a higher percentage of the misfire events during the conditions.

(h)(2)(iii)(D) The manufacturer may disable misfire monitoring or use an alternative malfunction criterion when misfire cannot be distinguished from other effects. To do so, the manufacturer must demonstrate that the disablement interval or the period of use of an alternative malfunction criterion is limited only to that necessary for avoiding false detection and for one or more of the following operating conditions: rough road; fuel cut; gear changes for manual transmission vehicles; traction control or other vehicle stability control activation such as anti-lock braking or other engine torque modifications to enhance vehicle stability; off-board control or intrusive activation of vehicle components or monitors during service or assembly plant testing; portions of intrusive evaporative system or EGR monitors that can significantly affect engine stability (i.e., while the purge valve is open during the vacuum pull-down of a evaporative system leak check but not while the purge valve is closed and the evaporative system is sealed or while an EGR monitor causes the EGR valve to be cycled intrusively on and off during positive torque conditions); or, engine speed, load, or torque transients due to throttle movements more rapid than those that occur over the FTP cycle for the worst case engine within each engine family. In general, the Administrator will not approve disablement for conditions involving normal air conditioning compressor cycling from on-to-off or off-to-on, automatic transmission gear shifts (except for shifts occurring during wide open throttle operation), transitions from idle to off-idle, normal engine speed or load changes that occur during the engine speed rise time and settling time (i.e., “flare-up” and “flare-down”) immediately after engine starting without any vehicle

operator-induced actions (e.g., throttle stabs), or excess acceleration (except for acceleration rates that exceed the maximum acceleration rate obtainable at wide open throttle while the vehicle is in gear due to abnormal conditions such as slipping of a clutch).

(h)(2)(iv) *MIL activation and DTC storage for engine misfire causing catalyst damage*.

(h)(2)(iv)(A) *Pending DTCs*. A pending DTC must be stored immediately if, during a single drive cycle, the specified misfire percentage described in paragraph (h)(2)(ii)(A) of this section is exceeded three times when operating in the positive torque region encountered during a FTP cycle or is exceeded on a single occasion when operating at any other engine speed and load condition in the positive torque region defined in paragraph (h)(2)(iii)(A) of this section. Immediately after a pending DTC is stored pursuant to this paragraph, the MIL must blink once per second at all times during the drive cycle that engine misfire is occurring. The MIL may be deactivated during those times that misfire is not occurring. If, at the time that a catalyst damaging misfire malfunction occurs, the MIL is already activated for a malfunction other than misfire, the MIL must still blink once per second at all times during the drive cycle that engine misfire is occurring. If misfire ceases, the MIL must stop blinking but remain activated as appropriate in accordance with the other malfunction.

(h)(2)(iv)(B) *MIL-on DTCs*. If a pending DTC is stored in accordance with paragraph (h)(2)(iv)(A) of this section, the OBD system must immediately store a MIL-on DTC if the percentage of misfire described in paragraph (h)(2)(ii)(A) of this section is again exceeded one or more times during either the drive cycle immediately following storage of the pending DTC, regardless of the conditions encountered during that drive cycle, or on the next drive cycle in which similar conditions are encountered to those that occurred when the pending DTC was stored. If, during a previous drive cycle, a pending DTC is stored in accordance with paragraph (h)(2)(iv)(A) of this section, a MIL-on DTC must be stored immediately upon exceeding the percentage misfire described in paragraph (h)(2)(ii)(A) of this section regardless of the conditions encountered. Upon storage of a MIL-on DTC, the MIL must blink once per second at all times during the drive cycle that engine misfire is occurring. If misfire ceases, the MIL must stop blinking but remain activated until the conditions are met for extinguishing the MIL.

(h)(2)(iv)(C) *Erasure of pending DTCs*. Pending DTCs stored in accordance with paragraph (h)(2)(iv)(A) of this section must be erased at the end of the next drive cycle in which similar conditions are encountered to those that occurred when the pending DTC was stored provided no exceedances have been detected of the misfire percentage described in paragraph (h)(2)(ii)(A) of this section. The pending DTC may also be erased if similar conditions are not encountered during the next 80 drive cycles immediately following storage of the pending DTC.

(h)(2)(iv)(D) *Exemptions for engines with fuel shutoff and default fuel control*. In engines that provide for fuel shutoff and default fuel control to prevent over fueling during catalyst damaging misfire conditions, the MIL need not blink as required by paragraphs (h)(2)(iv)(A) and (h)(2)(iv)(B) of this section. Instead, the MIL may be activated continuously upon misfire detection provided that the fuel shutoff and default fuel control are activated immediately upon misfire detection. Fuel shutoff and default fuel control may be deactivated only when the engine is outside of the misfire range except that the manufacturer may periodically, but not more than once every 30 seconds, deactivate fuel shutoff and default fuel control to determine if the catalyst damaging misfire is still occurring. Normal fueling and fuel control may be resumed if the catalyst damaging misfire is no longer occurring.

(h)(2)(iv)(E) The manufacturer may use a strategy that activates the MIL continuously rather than blinking the MIL during extreme catalyst damage misfire conditions (i.e., catalyst damage misfire occurring at all engine speeds and loads). Use of such a strategy must be limited to catalyst damage misfire levels that cannot be avoided during reasonable driving conditions. To use such a strategy, the manufacturer must be able to demonstrate that the strategy will encourage operation of the vehicle in conditions that will minimize catalyst damage (e.g., at low engine speeds and loads).

(h)(2)(v) *MIL activation and DTC storage for engine misfire causing emissions to exceed applicable emissions thresholds*.

(h)(2)(v)(A) Immediately upon detection, during the first 1000 revolutions after engine start of the misfire percentage described in paragraph (h)(2)(ii)(B) of this section, a pending DTC must be stored. If such a pending DTC is stored already and another such exceedance of the misfire

percentage is detected within the first 1000 revolutions after engine start on any subsequent drive cycle, the MIL must activate and a MIL-on DTC must be stored. The pending DTC may be erased if, at the end of the next drive cycle in which similar conditions are encountered to those that occurred when the pending DTC was stored, there has been no exceedance of the misfire percentage described in paragraph (h)(2)(ii)(B) of this section. The pending DTC may also be erased if similar conditions are not encountered during the next 80 drive cycles immediately following storage of the pending DTC.

(h)(2)(v)(B) No later than the fourth detection during a single drive cycle, following the first 1000 revolutions after engine start of the misfire percentage described in paragraph (h)(2)(ii)(B) of this section, a pending DTC must be stored. If such a pending DTC is stored already, then the MIL must activate and a MIL-on DTC must be stored within 10 seconds of the fourth detection of the misfire percentage described in paragraph (h)(2)(ii)(B) of this section during either the drive cycle immediately following storage of the pending DTC, regardless of the conditions encountered during that drive cycle excepting those conditions within the first 1000 revolutions after engine start, or on the next drive cycle in which similar conditions are encountered to those that occurred when the pending DTC was stored excepting those conditions within the first 1000 revolutions after engine start. The pending DTC may be erased if, at the end of the next drive cycle in which similar conditions are encountered to those that occurred when the pending DTC was stored, there has been no exceedance of the misfire percentage described in paragraph (h)(2)(ii)(B) of this section. The pending DTC may also be erased if similar conditions are not encountered during the next 80 drive cycles immediately following storage of the pending DTC.

(h)(2)(vi) *Storage of freeze frame conditions for engine misfire*.

(h)(2)(vi)(A) The OBD system must store and erase freeze frame conditions (as defined in paragraph (k)(4)(iii) of this section) either in conjunction with storing and erasing a pending DTC or in conjunction with storing and erasing a MIL-on DTC.

(h)(2)(vi)(B) If, upon storage of a DTC as required by paragraphs (h)(2)(iv) and (h)(2)(v) of this section, there already exist stored freeze frame conditions for a malfunction other than a misfire or fuel system malfunction (see paragraph (h)(1) of this section) then the stored freeze frame information shall be replaced with freeze frame information associated with the misfire malfunction.

(h)(2)(vii) *Storage of engine conditions in association with engine misfire*. Upon detection of the misfire percentages described in paragraphs (h)(2)(ii)(A) and (h)(2)(ii)(B) of this section, the following engine conditions must be stored for use in determining similar conditions: engine speed, load, and warm up status of the first misfire event that resulted in pending DTC storage.

(h)(2)(viii) *MIL deactivation in association with engine misfire*. The MIL may be deactivated after three sequential drive cycles in which similar conditions have been encountered without an exceedance of the misfire percentages described in paragraphs (h)(2)(ii)(A) and (h)(2)(ii)(B) of this section.

(h)(3) EGR system

(h)(3) *Exhaust gas recirculation system monitoring*.

(h)(3)(i) *General*. The OBD system must monitor the EGR system on engines so equipped for low and high flow rate malfunctions. The individual electronic components (e.g., actuators, valves, sensors) that are used in the EGR system must be monitored in accordance with the comprehensive component requirements in paragraph (i)(3) of this section.

(h)(3)(ii) *EGR system malfunction criteria*.

(h)(3)(ii)(A) The OBD system must detect a malfunction of the EGR system prior to a decrease from the manufacturer's specified EGR flow rate that would cause an engine's emissions to exceed the emissions thresholds for "other monitors" as shown in Table 2 of this paragraph (h). For engines in which no failure or deterioration of the EGR system that causes a decrease in flow could result in an engine's emissions exceeding the applicable emissions thresholds, the OBD system must detect a malfunction when the system has no detectable amount of EGR flow.

(h)(3)(ii)(B) The OBD system must detect a malfunction of the EGR system prior to an increase from the manufacturer's specified EGR flow rate that would cause an engine's emissions to exceed the emissions thresholds for "other monitors" as shown in Table 2 of this

paragraph (h). For engines in which no failure or deterioration of the EGR system that causes an increase in flow could result in an engine's emissions exceeding the applicable emissions thresholds, the OBD system must detect a malfunction when the system has reached its control limits such that it cannot reduce EGR flow.

(h)(3)(iii) *EGR system monitoring conditions*.

(h)(3)(iii)(A) The manufacturer must define the monitoring conditions for malfunctions identified in paragraph (h)(3)(ii) of this section in accordance with paragraphs (c) and (d) of this section. For purposes of tracking and reporting as required by paragraph (d)(1) of this section, all monitors used to detect malfunctions identified in paragraph (h)(3)(ii) of this section must be tracked separately but reported as a single set of values as specified in paragraph (e)(1)(iii) of this section.

(h)(3)(iii)(B) The manufacturer may disable temporarily the EGR monitor under conditions when monitoring may not be reliable (e.g., when freezing may affect performance of the system). To do so, the manufacturer must be able to demonstrate that the monitor is unreliable when such conditions exist.

(h)(3)(iv) *EGR system MIL activation and DTC storage*. The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(h)(4) Cold start strategy

(h)(4) *Cold start emission reduction strategy monitoring*.

(h)(4)(i) *General*. If an engine incorporates a specific engine control strategy to reduce cold start emissions, the OBD system must monitor the key components (e.g., idle air control valve), other than secondary air, while the control strategy is active to ensure proper operation of the control strategy.

(h)(4)(ii) *Cold start strategy malfunction criteria*.

(h)(4)(ii)(A) The OBD system must detect a malfunction prior to any failure or deterioration of the individual components associated with the cold start emission reduction control strategy that would cause an engine's emissions to exceed the emissions thresholds for "other monitors" as shown in Table 2 of this paragraph (h). The manufacturer must establish the malfunction criteria based on data from one or more representative engine(s) and provide an engineering evaluation for establishing the malfunction criteria for the remainder of the manufacturer's product line.

(h)(4)(ii)(B) Where no failure or deterioration of a component used for the cold start emission reduction strategy could result in an engine's emissions exceeding the applicable emissions thresholds, the individual component must be monitored for proper functional response while the control strategy is active in accordance with the malfunction criteria in paragraphs (i)(3)(ii) and (i)(3)(iii) of this section.

(h)(4)(iii) *Cold start strategy monitoring conditions*. The manufacturer must define monitoring conditions for malfunctions identified in paragraph (h)(4)(ii) of this section in accordance with paragraphs (c) and (d) of this section.

(h)(4)(iv) *Cold start strategy MIL activation and DTC storage*. The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(h)(5) Secondary air system

(h)(5) *Secondary air system monitoring*.

(h)(5)(i) *General*. The OBD system on engines equipped with any form of secondary air delivery system must monitor the proper functioning of the secondary air delivery system including all air switching valves(s). The individual electronic components (e.g., actuators, valves, sensors) that are used in the secondary air system must be monitored in accordance with the comprehensive component requirements in paragraph (i)(3) of this section. For purposes of this paragraph (h)(5), "air flow" is defined as the air flow delivered by the secondary air system to the exhaust system. For engines using secondary air systems with multiple air flow paths/distribution points, the air flow to each bank (i.e., a group of cylinders that share a common exhaust manifold, catalyst, and control sensor) must be monitored in accordance with the malfunction criteria in paragraph (h)(5)(ii) of this section. Also for purposes of this paragraph (h)(5), "normal operation" is defined as the condition when the secondary air system is activated during catalyst and/or engine warm-up following engine start. "Normal operation" does not include the condition when the secondary air system is turned on intrusively for the sole purpose of monitoring.

(h)(5)(ii) *Secondary air system malfunction criteria*.

(h)(5)(ii)(A) Except as provided in paragraph (h)(5)(ii)(C) of this section, the OBD system must detect a secondary air system malfunction prior to a decrease from the manufacturer's specified air flow during normal operation that would cause an engine's emissions to exceed the emissions thresholds for "other monitors" as shown in Table 2 of this paragraph (h).

(h)(5)(ii)(B) Except as provided in paragraph (h)(5)(ii)(C) of this section, the OBD system must detect a secondary air system malfunction prior to an increase from the manufacturer's specified air flow during normal operation that would cause an engine's emissions to exceed the emissions thresholds for "other monitors" as shown in Table 2 of this paragraph (h).

(h)(5)(ii)(C) For engines in which no deterioration or failure of the secondary air system would result in an engine's emissions exceeding the applicable emissions thresholds, the OBD system must detect a malfunction when no detectable amount of air flow is delivered by the secondary air system during normal operation.

(h)(5)(iii) *Secondary air system monitoring conditions*. The manufacturer must define monitoring conditions for malfunctions identified in paragraph (h)(5)(ii) of this section in accordance with paragraphs (c) and (d) of this section. For purposes of tracking and reporting as required by paragraph (d)(1) of this section, all monitors used to detect malfunctions identified in paragraph (h)(5)(ii) of this section must be tracked separately but reported as a single set of values as specified in paragraph (e)(1)(iii) of this section.

(h)(5)(iv) *Secondary air system MIL activation and DTC storage*. The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(h)(6) Catalyst system

(h)(6) *Catalyst system monitoring*.

(h)(6)(i) *General*. The OBD system must monitor the catalyst system for proper conversion capability.

(h)(6)(ii) *Catalyst system malfunction criteria*. The OBD system must detect a catalyst system malfunction when the catalyst system's conversion capability decreases to the point that emissions exceed the emissions thresholds for the catalyst system as shown in Table 2 of this paragraph (h).

(h)(6)(iii) *Catalyst system monitoring conditions*. The manufacturer must define monitoring conditions for malfunctions identified in paragraph (h)(6)(ii) of this section in accordance with paragraphs (c) and (d) of this section. For purposes of tracking and reporting as required by paragraph (d)(1) of this section, all monitors used to detect malfunctions identified in paragraph (h)(6)(ii) of this section must be tracked separately but reported as a single set of values as specified in paragraph (e)(1)(iii) of this section.

(h)(6)(iv) *Catalyst system MIL activation and DTC storage*.

(h)(6)(iv)(A) The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(h)(6)(iv)(B) The monitoring method for the catalyst system must be capable of detecting when a catalyst DTC has been erased (except OBD system self erasure), but the catalyst has not been replaced (e.g., catalyst overtemperature histogram approaches are not acceptable).

(h)(7) Evaporative system

(h)(7) *Evaporative system monitoring*.

(h)(7)(i) *General*. The OBD system must verify purge flow from the evaporative system and monitor the complete evaporative system, excluding the tubing and connections between the purge valve and the intake manifold, for vapor leaks to the atmosphere. Individual components of the evaporative system (e.g. valves, sensors) must be monitored in accordance with the comprehensive components requirements in paragraph (i)(3) of this section.

(h)(7)(ii) *Evaporative system malfunction criteria*.

(h)(7)(ii)(A) *Purge monitor*. The OBD system must detect an evaporative system malfunction when no purge flow from the evaporative system to the engine can be detected by the OBD system.

(h)(7)(ii)(B) *Leak monitor*. The OBD system must detect an evaporative system malfunction when the complete evaporative system contains a leak or leaks that cumulatively are greater than or equal to a leak caused by a 0.150 inch diameter hole.

(h)(7)(ii)(C) The manufacturer may demonstrate that detection of a larger hole is more appropriate than that specified in paragraph (h)(7)(ii)(B) of this section. To do so, the manufacturer must demonstrate through data and/or engineering analyses that holes smaller than the proposed detection size would not result in evaporative or running loss emissions that exceed 1.5 times the applicable evaporative emissions standards. Upon such a demonstration, the proposed detection size could be substituted for the requirement of paragraph (h)(7)(ii)(B) of this section.

(h)(7)(iii) *Evaporative system monitoring conditions*.

(h)(7)(iii)(A) The manufacturer must define monitoring conditions for malfunctions identified in paragraph (h)(7)(ii)(A) of this section in accordance with paragraphs (c) and (d) of this section.

(h)(7)(iii)(B) The manufacturer must define monitoring conditions for malfunctions identified in paragraph (h)(7)(ii)(B) of this section in accordance with paragraphs (c) and (d) of this section. For purposes of tracking and reporting as required by paragraph (d)(1) of this section, all monitors used to detect malfunctions identified in paragraph (h)(7)(ii)(B) of this section must be tracked separately but reported as a single set of values as specified in paragraph (e)(1)(iii) of this section.

(h)(7)(iii)(C) The manufacturer may disable or abort an evaporative system monitor when the fuel tank level is over 85 percent of nominal tank capacity or during a refueling event.

(h)(7)(iii)(D) The manufacturer may request Administrator approval to run the evaporative system monitor during only those drive cycles characterized as cold starts provided such a condition is needed to ensure reliable monitoring. In making the request, the manufacturer must demonstrate through data and/or engineering analyses that a reliable monitor can only be run on drive cycles that begin with a specific set of cold start criteria. A set of cold start criteria based solely on ambient temperature exceeding engine coolant temperature will not be acceptable.

(h)(7)(iii)(E) The OBD system may disable temporarily the evaporative purge system to run an evaporative system leak monitor.

(h)(7)(iv) *Evaporative system MIL activation and DTC storage*.

(h)(7)(iv)(A) Except as provided for in paragraph (h)(7)(iv)(B) of this section, the MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(h)(7)(iv)(B) If the OBD system is capable of discerning that a system leak is being caused by a missing or improperly secured gas cap, the OBD system need not activate the MIL or store a DTC provided the vehicle is equipped with an alternative indicator for notifying the operator of the gas cap problem. The alternative indicator must be of sufficient illumination and location to be readily visible under all lighting conditions. If the vehicle is not equipped with such an alternative indicator, the MIL must activate and a DTC be stored as required in paragraph (h)(7)(iv)(A) of this section; however, these may be deactivated and erased, respectively, if the OBD system determines that the gas cap problem has been corrected and the MIL has not been activated for any other malfunction. The Administrator may approve other strategies that provide equivalent assurance that a vehicle operator will be notified promptly of a missing or improperly secured gas cap and that corrective action will be undertaken.

(h)(8) Exhaust gas sensors

(h)(8) *Exhaust gas sensor monitoring*.

(h)(8)(i) *General*.

(h)(8)(i)(A) The OBD system must monitor for malfunctions the output signal, response rate, and any other parameter that can affect emissions of all primary (i.e., fuel control) exhaust gas sensors (e.g., oxygen, wide-range air/fuel). Both the lean-to-rich and rich-to-lean response rates must be monitored.

(h)(8)(i)(B) The OBD system must also monitor all secondary exhaust gas sensors (those used for secondary fuel trim control or as a monitoring device) for proper output signal, activity, and response rate.

(h)(8)(i)(C) For engines equipped with heated exhaust gas sensor, the OBD system must monitor the heater for proper performance.

(h)(8)(ii) *Primary exhaust gas sensor malfunction criteria*.

(h)(8)(ii)(A) The OBD system must detect a malfunction prior to any failure or deterioration of the exhaust gas sensor output voltage, resistance, impedance, current, response rate, amplitude, offset, or other characteristic(s) (including drift or bias corrected for by secondary sensors) that

would cause an engine's emissions to exceed the emissions thresholds for "other monitors" as shown in Table 2 of this paragraph (h).

(h)(8)(ii)(B) The OBD system must detect malfunctions of the exhaust gas sensor caused by either a lack of circuit continuity or out-of-range values.

(h)(8)(ii)(C) The OBD system must detect a malfunction of the exhaust gas sensor when a sensor failure or deterioration causes the fuel system to stop using that sensor as a feedback input (e.g., causes default or open-loop operation).

(h)(8)(ii)(D) The OBD system must detect a malfunction of the exhaust gas sensor when the sensor output voltage, resistance, impedance, current, amplitude, activity, or other characteristics are no longer sufficient for use as an OBD system monitoring device (e.g., for catalyst monitoring).

(h)(8)(iii) *Secondary exhaust gas sensor malfunction criteria*.

(h)(8)(iii)(A) The OBD system must detect a malfunction prior to any failure or deterioration of the exhaust gas sensor voltage, resistance, impedance, current, response rate, amplitude, offset, or other characteristic(s) that would cause an engine's emissions to exceed the emissions thresholds for "other monitors" as shown in Table 2 of this paragraph (h).

(h)(8)(iii)(B) The OBD system must detect malfunctions of the exhaust gas sensor caused by a lack of circuit continuity.

(h)(8)(iii)(C) To the extent feasible, the OBD system must detect a malfunction of the exhaust gas sensor when the sensor output voltage, resistance, impedance, current, amplitude, activity, offset, or other characteristics are no longer sufficient for use as an OBD system monitoring device (e.g., for catalyst monitoring).

(h)(8)(iii)(D) The OBD system must detect malfunctions of the exhaust gas sensor caused by out-of-range values.

(h)(8)(iii)(E) The OBD system must detect a malfunction of the exhaust gas sensor when a sensor failure or deterioration causes the fuel system (e.g., fuel control) to stop using that sensor as a feedback input (e.g., causes default or open-loop operation).

(h)(8)(iv) *Exhaust gas sensor heater malfunction criteria*.

(h)(8)(iv)(A) The OBD system must detect a malfunction of the heater performance when the current or voltage drop in the heater circuit is no longer within the manufacturer's specified limits for normal operation (i.e., within the criteria required to be met by the component vendor for heater circuit performance at high mileage). Other malfunction criteria for heater performance malfunctions may be used upon demonstrating via data or engineering analyses that the monitoring reliability and timeliness is equivalent to the stated criteria in this paragraph (h)(8)(iv)(A).

(h)(8)(iv)(B) The OBD system must detect malfunctions of the heater circuit including open or short circuits that conflict with the commanded state of the heater (e.g., shorted to 12 Volts when commanded to 0 Volts (ground)).

(h)(8)(v) *Primary exhaust gas sensor monitoring conditions*.

(h)(8)(v)(A) The manufacturer must define monitoring conditions for malfunctions identified in paragraphs (h)(8)(ii)(A) and (h)(8)(ii)(D) of this section in accordance with paragraphs (c) and (d) of this section. For purposes of tracking and reporting as required by paragraph (d)(1) of this section, all monitors used to detect malfunctions identified in paragraphs (h)(8)(ii)(A) and (h)(8)(ii)(D) of this section must be tracked separately but reported as a single set of values as specified in paragraph (e)(1)(iii) of this section.

(h)(8)(v)(B) Except as provided for in paragraph (h)(8)(v)(C) of this section, monitoring for malfunctions identified in paragraphs (h)(8)(ii)(B) and (h)(8)(ii)(C) of this section must be conducted continuously.

(h)(8)(v)(C) The manufacturer may disable continuous primary exhaust gas sensor monitoring when a primary exhaust gas sensor malfunction cannot be distinguished from other effects (e.g., disable out-of-range low monitoring during fuel cut conditions). To do so, the manufacturer must demonstrate via data or engineering analyses that a properly functioning sensor cannot be distinguished from a malfunctioning sensor and that the disablement interval is limited only to that necessary for avoiding false detection.

(h)(8)(vi) *Secondary exhaust gas sensor monitoring conditions*.

(h)(8)(vi)(A) The manufacturer must define monitoring conditions for malfunctions identified in paragraphs (h)(8)(iii)(A) through (h)(8)(iii)(C) of this section in accordance with paragraphs (c) and (d) of this section.

(h)(8)(vi)(B) Except as provided for in paragraph (h)(8)(vi)(C) of this section, monitoring for malfunctions identified in paragraphs (h)(8)(iii)(D) and (h)(8)(iii)(E) of this section must be conducted continuously.

(h)(8)(vi)(C) The manufacturer may disable continuous secondary exhaust gas sensor monitoring when a secondary exhaust gas sensor malfunction cannot be distinguished from other effects (e.g., disable out-of-range low monitoring during fuel cut conditions). To do so, the manufacturer must demonstrate via data or engineering analyses that a properly functioning sensor cannot be distinguished from a malfunctioning sensor and that the disablement interval is limited only to that necessary for avoiding false detection.

(h)(8)(vii) *Exhaust gas sensor heater monitoring conditions*.

(h)(8)(vii)(A) The manufacturer must define monitoring conditions for malfunctions identified in paragraph (h)(8)(iv)(A) of this section in accordance with paragraphs (c) and (d) of this section.

(h)(8)(vii)(B) Monitoring for malfunctions identified in paragraph (h)(8)(iv)(B) of this section must be conducted continuously.

(h)(8)(viii) *Exhaust gas sensor MIL activation and DTC storage*. The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(h)(9) VVT system

(h)(9) *Variable valve timing (VVT) system monitoring*.

(h)(9)(i) *General*. The OBD system must monitor the VVT system on engines so equipped for target error and slow response malfunctions. The individual electronic components (e.g., actuators, valves, sensors) that are used in the VVT system must be monitored in accordance with the comprehensive components requirements in paragraph (i)(3) of this section.

(h)(9)(ii) *VVT system malfunction criteria*.

(h)(9)(ii)(A) *VVT system target error*. The OBD system must detect a malfunction prior to any failure or deterioration in the capability of the VVT system to achieve the commanded valve timing and/or control within a crank angle and/or lift tolerance that would cause an engine's emissions to exceed the emission thresholds for "other monitors" as shown in Table 2 of this paragraph (h).

(h)(9)(ii)(B) *VVT slow response*. The OBD system must detect a malfunction prior to any failure or deterioration in the capability of the VVT system to achieve the commanded valve timing and/or control within a manufacturer-specified time that would cause an engine's emissions to exceed the emission thresholds for "other monitors" as shown in Table 2 of this paragraph (h).

(h)(9)(ii)(C) For engines in which no failure or deterioration of the VVT system could result in an engine's emissions exceeding the applicable emissions thresholds of paragraphs (h)(9)(ii)(A) and (h)(9)(ii)(B) of this paragraph (h), the OBD system must detect a malfunction of the VVT system when proper functional response of the system to computer commands does not occur.

(h)(9)(iii) *VVT system monitoring conditions*. Manufacturers must define the monitoring conditions for VVT system malfunctions identified in paragraph (h)(9)(ii) of this section in accordance with paragraphs (c) and (d) of this section, with the exception that monitoring must occur every time the monitoring conditions are met during the drive cycle rather than once per drive cycle as required in paragraph (c)(2) of this section. For purposes of tracking and reporting as required in paragraph (d)(1) of this section, all monitors used to detect malfunctions identified in paragraph (h)(9)(ii) of this section must be tracked separately but reported as a single set of values as specified in paragraph (e)(1)(iii) of this section.

(h)(9)(iv) *VVT MIL activation and DTC storage*. The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(i) Monitoring requirements for all engines

(i) *OBD monitoring requirements for all engines*.

(i)(1) Cooling system

(i)(1) *Engine cooling system monitoring*.

(i)(1)(i) *General*.

(i)(1)(i)(A) The OBD system must monitor the thermostat on engines so equipped for proper operation.

(i)(1)(i)(B) The OBD system must monitor the engine coolant temperature (ECT) sensor for electrical circuit continuity, out-of-range values, and rationality malfunctions.

(i)(1)(i)(C) For engines that use a system other than the cooling system and ECT sensor (e.g., oil temperature, cylinder head temperature) to determine engine operating temperature for emission control purposes (e.g., to modify spark or fuel injection timing or quantity), the manufacturer may forego cooling system monitoring and instead monitor the components or systems used in their approach. To do so, the manufacturer must to submit data and/or engineering analyses that demonstrate that their monitoring plan is as reliable and effective as the monitoring required in this paragraph (i)(1).

(i)(1)(ii) *Malfunction criteria for the thermostat*.

(i)(1)(ii)(A) The OBD system must detect a thermostat malfunction if, within the manufacturer specified time interval following engine start, any of the following conditions occur: the coolant temperature does not reach the highest temperature required by the OBD system to enable other diagnostics; and, the coolant temperature does not reach a warmed-up temperature within 20 degrees Fahrenheit of the manufacturer's nominal thermostat regulating temperature. For the second of these two conditions, the manufacturer may use a lower temperature for this criterion provided the manufacturer can demonstrate that the fuel, spark timing, and/or other coolant temperature-based modification to the engine control strategies would not cause an emissions increase greater than or equal to 50 percent of any of the applicable emissions standards.

(i)(1)(ii)(B) The manufacturer may use alternative malfunction criteria to those of paragraph (i)(1)(ii)(A) of this section and/or alternative monitoring conditions to those of paragraph (i)(1)(iv) of this section that are a function of temperature at engine start on engines that do not reach the temperatures specified in the malfunction criteria when the thermostat is functioning properly. To do so, the manufacturer is required to submit data and/or engineering analyses that demonstrate that a properly operating system does not reach the specified temperatures and that the possibility is minimized for cooling system malfunctions to go undetected thus disabling other OBD monitors.

(i)(1)(ii)(C) The manufacturer may request Administrator approval to forego monitoring of the thermostat if the manufacturer can demonstrate that a malfunctioning thermostat cannot cause a measurable increase in emissions during any reasonable driving condition nor cause any disablement of other OBD monitors.

(i)(1)(iii) *Malfunction criteria for the ECT sensor*.

(i)(1)(iii)(A) *Circuit integrity*. The OBD system must detect malfunctions of the ECT sensor related to a lack of circuit continuity or out-of-range values.

(i)(1)(iii)(B) *Time to reach closed-loop/feedback enable temperature*. The OBD system must detect if, within the manufacturer specified time interval following engine start, the ECT sensor does not achieve the highest stabilized minimum temperature that is needed to initiate closed-loop/feedback control of all affected emission control systems (e.g., fuel system, EGR system). The manufacturer specified time interval must be a function of the engine coolant temperature and/or intake air temperature at startup. The manufacturer time interval must be supported by data and/or engineering analyses demonstrating that it provides robust monitoring and minimizes the likelihood of other OBD monitors being disabled. The manufacturer may forego the requirements of this paragraph (i)(1)(iii)(B) provided the manufacturer does not use engine coolant temperature or the ECT sensor to enable closed-loop/feedback control of any emission control systems.

(i)(1)(iii)(C) *Stuck in range below the highest minimum enable temperature*. To the extent feasible when using all available information, the OBD system must detect a malfunction if the ECT sensor inappropriately indicates a temperature below the highest minimum enable temperature required by the OBD system to enable other monitors (e.g., an OBD system that requires ECT to be greater than 140 degrees Fahrenheit to enable a diagnostic must detect malfunctions that cause the ECT sensor to inappropriately indicate a temperature below 140 degrees Fahrenheit). The manufacturer may forego this requirement for temperature regions in which the monitors required under paragraphs (i)(1)(ii) or (i)(1)(iii)(B) of this section will detect ECT sensor malfunctions as defined in this paragraph (i)(1)(iii)(C).

(i)(1)(iii)(D) *Stuck in range above the lowest maximum enable temperature*. The OBD system must detect a malfunction if the ECT sensor inappropriately indicates a temperature above the lowest maximum enable temperature required by the OBD system to enable other monitors (e.g., an OBD system that requires an engine coolant temperature less than 90 degrees Fahrenheit at startup prior to enabling an OBD monitor must detect malfunctions that cause the ECT sensor to indicate inappropriately a temperature above 90 degrees Fahrenheit). The manufacturer may forego this requirement within temperature regions in which the monitors required under paragraphs (i)(1)(ii), (i)(1)(iii)(B), and (i)(1)(iii)(C) of this section will detect ECT sensor malfunctions as defined in this paragraph (i)(1)(iii)(D) or in which the MIL will be activated according to the provisions of paragraph (b)(2)(v) of this section. The manufacturer may also forego this monitoring within temperature regions where a temperature gauge on the instrument panel indicates a temperature in the "red zone" (engine overheating zone) and displays the same temperature information as used by the OBD system.

(i)(1)(iv) *Monitoring conditions for the thermostat*.

(i)(1)(iv)(A) The manufacturer must define the monitoring conditions for malfunctions identified in paragraph (i)(1)(ii)(A) of this section in accordance with paragraph (c) of this section. Additionally, except as provided for in paragraphs (i)(1)(iv)(B) and (i)(1)(iv)(C) of this section, monitoring for malfunctions identified in paragraph (i)(1)(ii)(A) of this section must be conducted once per drive cycle on every drive cycle in which the ECT sensor indicates, at engine start, a temperature lower than the temperature established as the malfunction criteria in paragraph (i)(1)(ii)(A) of this section.

(i)(1)(iv)(B) The manufacturer may disable thermostat monitoring at ambient engine start temperatures below 20 degrees Fahrenheit.

(i)(1)(iv)(C) The manufacturer may request Administrator approval to suspend or disable thermostat monitoring if the engine is subjected to conditions that could lead to false diagnosis. To do so, the manufacturer must submit data and/or engineering analyses that demonstrate that the suspension or disablement is necessary. In general, the manufacturer will not be allowed to suspend or disable the thermostat monitor on engine starts where the engine coolant temperature at engine start is more than 35 degrees Fahrenheit lower than the thermostat malfunction threshold temperature determined under paragraph (i)(1)(ii)(A) of this paragraph (i)(1).

(i)(1)(v) *Monitoring conditions for the ECT sensor*.

(i)(1)(v)(A) Except as provided for in paragraph (i)(1)(v)(E) of this section, the OBD system must monitor continuously for malfunctions identified in paragraph (i)(1)(iii)(A) of this section (i.e., circuit integrity and out-of-range).

(i)(1)(v)(B) The manufacturer must define the monitoring conditions for malfunctions identified in paragraph (i)(1)(iii)(B) of this section in accordance with paragraph (c) of this section. Additionally, except as provided for in paragraph (i)(1)(v)(D) of this section, monitoring for malfunctions identified in paragraph (i)(1)(iii)(B) of this section must be conducted once per drive cycle on every drive cycle in which the ECT sensor indicates a temperature lower than the closed-loop enable temperature at engine start (i.e., all engine start temperatures greater than the ECT sensor out-of-range low temperature and less than the closed-loop enable temperature).

(i)(1)(v)(C) The manufacturer must define the monitoring conditions for malfunctions identified in paragraphs (i)(1)(iii)(C) and (i)(1)(iii)(D) of this section in accordance with paragraphs (c) and (d) of this section.

(i)(1)(v)(D) The manufacturer may suspend or delay the monitor for the time to reach closed-loop enable temperature if the engine is subjected to conditions that could lead to false diagnosis (e.g., vehicle operation at idle for more than 50 to 75 percent of the warm-up time).

(i)(1)(v)(E) The manufacturer may request Administrator approval to disable continuous ECT sensor monitoring when an ECT sensor malfunction cannot be distinguished from other effects. To do so, the manufacturer must submit data and/or engineering analyses that demonstrate a properly functioning sensor cannot be distinguished from a malfunctioning sensor and that the disablement interval is limited only to that necessary for avoiding false detection.

(i)(1)(vi) *Engine cooling system MIL activation and DTC storage*. The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(i)(2) Crankcase ventilation system

(i)(2) *Crankcase ventilation (CV) system monitoring*.

(i)(2)(i) *General*. The OBD system must monitor the CV system on engines so equipped for system integrity. Engines not required to be equipped with CV systems are exempt from monitoring the CV system. For diesel engines, the manufacturer must submit a plan for Administrator prior to OBD certification. That plan must include descriptions of the monitoring strategy, malfunction criteria, and monitoring conditions for CV system monitoring. The plan must demonstrate that the CV system monitor is of equivalent effectiveness, to the extent feasible, to the malfunction criteria and the monitoring conditions of this paragraph (i)(2).

(i)(2)(ii) *Crankcase ventilation system malfunction criteria*.

(i)(2)(ii)(A) For the purposes of this paragraph (i)(2), "CV system" is defined as any form of crankcase ventilation system, regardless of whether it utilizes positive pressure. "CV valve" is defined as any form of valve or orifice used to restrict or control crankcase vapor flow. Further, any additional external CV system tubing or hoses used to equalize crankcase pressure or to provide a ventilation path between various areas of the engine (e.g., crankcase and valve cover) are considered part of the CV system "between the crankcase and the CV valve" and subject to the malfunction criteria in paragraph (i)(2)(ii)(B) of this section.

(i)(2)(ii)(B) Except as provided for in paragraphs (i)(2)(ii)(C) through (i)(2)(ii)(E) of this section, the OBD system must detect a malfunction of the CV system when a disconnection of the system occurs between either the crankcase and the CV valve, or between the CV valve and the intake manifold.

(i)(2)(ii)(C) The manufacturer may forego monitoring for a disconnection between the crankcase and the CV valve provided the CV system is designed such that the CV valve is fastened directly to the crankcase such that it is significantly more difficult to remove the CV valve from the crankcase than to disconnect the line between the CV valve and the intake manifold (taking aging effects into consideration). To do so, the manufacturer must be able to provide data and/or an engineering evaluation demonstrating that the CV system is so designed.

(i)(2)(ii)(D) The manufacturer may forego monitoring for a disconnection between the crankcase and the CV valve provided the CV system is designed such that it uses tubing connections between the CV valve and the crankcase that are: resistant to deterioration or accidental disconnection; significantly more difficult to disconnect than is the line between the CV valve and the intake manifold; and, not subject to disconnection per the manufacturer's repair procedures for any non-CV system repair. To do so, the manufacturer must be able to provide data and/or engineering evaluation demonstrating that the CV system is so designed.

(i)(2)(ii)(E) The manufacturer may forego monitoring for a disconnection between the CV valve and the intake manifold provided the CV system is designed such that any disconnection either causes the engine to stall immediately during idle operation, or is unlikely to occur due to a CV system design that is integral to the induction system (e.g., machined passages rather than tubing or hoses). To do so, the manufacturer must be able to provide data and/or an engineering evaluation demonstrating that the CV system is so designed.

(i)(2)(iii) *Crankcase ventilation system monitoring conditions*. The manufacturer must define the monitoring conditions for malfunctions identified in paragraph (i)(2) of this section in accordance with paragraphs (c) and (d) of this section.

(i)(2)(iv) *Crankcase ventilation system MIL activation and DTC storage*. The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section. The stored DTC need not identify specifically the CV system (e.g., a DTC for idle speed control or fuel system monitoring can be stored) if the manufacturer can demonstrate that additional monitoring hardware is necessary to make such an identification and provided the manufacturer's diagnostic and repair procedures for the detected malfunction include directions to check the integrity of the CV system.

(i)(3) Comprehensive components

(i)(3) *Comprehensive component monitoring*.

(i)(3)(i) *General*. Except as provided for in paragraph (i)(4) of this section, the OBD system must detect a malfunction of any electronic engine component or system not otherwise described in paragraphs (g), (h), (i)(1), and (i)(2) of this section that either provides input to (directly or

indirectly, such components may include the crank angle sensor, knock sensor, throttle position sensor, cam position sensor, intake air temperature sensor, boost pressure sensor, manifold pressure sensor, mass air flow sensor, exhaust temperature sensor, exhaust pressure sensor, fuel pressure sensor, fuel composition sensor of a flexible fuel vehicle, etc.) or receives commands from (such components or systems may include the idle speed control system, glow plug system, variable length intake manifold runner systems, supercharger or turbocharger electronic components, heated fuel preparation systems, the wait-to-start lamp on diesel applications, the MIL, etc.) the onboard computer(s) and meets either of the criteria described in paragraphs (i)(3)(i)(A) and/or (i)(3)(i)(B) of this section. Note that, for the purposes of this paragraph (i)(3), "electronic engine component or system" does not include components that are driven by the engine and are not related to the control of the fueling, air handling, or emissions of the engine (e.g., power take-off (PTO) components, air conditioning system components, and power steering components).

(i)(3)(i)(A) It can affect emissions during any reasonable in-use driving condition. The manufacturer must be able to provide emission data showing that the component or system, when malfunctioning and installed on a suitable test engine, does not have an emission effect.

(i)(3)(i)(B) It is used as part of the monitoring strategy for any other monitored system or component.

(i)(3)(ii) *Comprehensive component malfunction criteria for input components*.

(i)(3)(ii)(A) The OBD system must detect malfunctions of input components caused by a lack of circuit continuity and out-of-range values. In addition, where feasible, rationality checks must also be done and shall verify that a sensor output is neither inappropriately high nor inappropriately low (i.e., "two-sided" monitoring).

(i)(3)(ii)(B) To the extent feasible, the OBD system must separately detect and store different DTCs that distinguish rationality malfunctions from lack of circuit continuity and out-of-range malfunctions. For lack of circuit continuity and out-of-range malfunctions, the OBD system must, to the extent feasible, separately detect and store different DTCs for each distinct malfunction (e.g., out-of-range low, out-of-range high, open circuit). The OBD system is not required to store separate DTCs for lack of circuit continuity malfunctions that cannot be distinguished from other out-of-range circuit malfunctions.

(i)(3)(ii)(C) For input components that are used to activate alternative strategies that can affect emissions (e.g., AECDs, engine shutdown systems), the OBD system must conduct rationality checks to detect malfunctions that cause the system to activate erroneously or deactivate the alternative strategy. To the extent feasible when using all available information, the rationality check must detect a malfunction if the input component inappropriately indicates a value that activates or deactivates the alternative strategy. For example, for an alternative strategy that activates when the intake air temperature is greater than 120 degrees Fahrenheit, the OBD system must detect malfunctions that cause the intake air temperature sensor to indicate inappropriately a temperature above 120 degrees Fahrenheit.

(i)(3)(ii)(D) For engines that require precise alignment between the camshaft and the crankshaft, the OBD system must monitor the crankshaft position sensor(s) and camshaft position sensor(s) to verify proper alignment between the camshaft and crankshaft in addition to monitoring the sensors for circuit continuity and proper rationality. Proper alignment monitoring between a camshaft and a crankshaft is required only in cases where both are equipped with position sensors. For engines equipped with VVT systems and a timing belt or chain, the OBD system must detect a malfunction if the alignment between the camshaft and crankshaft is off by one or more cam/crank sprocket cogs (e.g., the timing belt/chain has slipped by one or more teeth/cogs). If a manufacturer demonstrates that a single tooth/cog misalignment cannot cause a measurable increase in emissions during any reasonable driving condition, the OBD system must detect a malfunction when the minimum number of teeth/cogs misalignment has occurred that does cause a measurable emission increase.

(i)(3)(iii) *Comprehensive component malfunction criteria for output components/systems*.

(i)(3)(iii)(A) The OBD system must detect a malfunction of an output component/system when proper functional response does not occur in response to computer commands. If such a functional check is not feasible, the OBD system must detect malfunctions of output components/systems caused by a lack of circuit continuity or circuit malfunction (e.g., short to

ground or high voltage). For output component lack of circuit continuity malfunctions and circuit malfunctions, the OBD system is not required to store different DTCs for each distinct malfunction (e.g., open circuit, shorted low). Manufacturers are not required to activate an output component/system when it would not normally be active for the sole purpose of performing a functional check of it as required in this paragraph (i)(3).

(i)(3)(iii)(B) For gasoline engines, the idle control system must be monitored for proper functional response to computer commands. For gasoline engines using monitoring strategies based on deviation from target idle speed, a malfunction must be detected when either of the following conditions occurs: the idle speed control system cannot achieve the target idle speed within 200 revolutions per minute (rpm) above the target speed or 100 rpm below the target speed; or, the idle speed control system cannot achieve the target idle speed within the smallest engine speed tolerance range required by the OBD system to enable any other monitors. Regarding the former of these conditions, the manufacturer may use larger engine speed tolerances. To do so, the manufacturer must be able to provide data and/or engineering analyses that demonstrate that the tolerances can be exceeded without a malfunction being present.

(i)(3)(iii)(C) For diesel engines, the idle control system must be monitored for proper functional response to computer commands. For diesel engines, a malfunction must be detected when either of the following conditions occurs: the idle fuel control system cannot achieve the target idle speed or fuel injection quantity within +/-50 percent of the manufacturer-specified fuel quantity and engine speed tolerances; or, the idle fuel control system cannot achieve the target idle speed or fueling quantity within the smallest engine speed or fueling quantity tolerance range required by the OBD system to enable any other monitors.

(i)(3)(iii)(D) Glow plugs/intake air heater systems must be monitored for proper functional response to computer commands and for circuit continuity malfunctions. The glow plug/intake air heater circuit(s) must be monitored for proper current and voltage drop. The manufacturer may use other monitoring strategies but must be able to provide data and/or engineering analyses that demonstrate reliable and timely detection of malfunctions. The OBD system must also detect a malfunction when a single glow plug no longer operates within the manufacturer's specified limits for normal operation. If a manufacturer can demonstrate that a single glow plug malfunction cannot cause a measurable increase in emissions during any reasonable driving condition, the OBD system must instead detect a malfunction when the number of glow plugs needed to cause an emission increase is malfunctioning. To the extent feasible, the stored DTC must identify the specific malfunctioning glow plug(s).

(i)(3)(iii)(E) The wait-to-start lamp circuit and the MIL circuit must be monitored for malfunctions that cause either lamp to fail to activate when commanded to do so (e.g., burned out bulb).

(i)(3)(iv) *Monitoring conditions for input components*.

(i)(3)(iv)(A) The OBD system must monitor input components continuously for out-of-range values and circuit continuity. The manufacturer may disable continuous monitoring for circuit continuity and out-of-range values when a malfunction cannot be distinguished from other effects. To do so, the manufacturer must be able to provide data and/or engineering analyses that demonstrate that a properly functioning input component cannot be distinguished from a malfunctioning input component and that the disablement interval is limited only to that necessary for avoiding false malfunction detection.

(i)(3)(iv)(B) For input component rationality checks (where applicable), the manufacturer must define the monitoring conditions for detecting malfunctions in accordance with paragraphs (c) and (d) of this section, with the exception that rationality checks must occur every time the monitoring conditions are met during the drive cycle rather than once per drive cycle as required in paragraph (c)(2) of this section.

(i)(3)(v) *Monitoring conditions for output components/systems*.

(i)(3)(v)(A) The OBD system must monitor output components/systems continuously for circuit continuity and circuit malfunctions. The manufacturer may disable continuous monitoring for circuit continuity and circuit malfunctions when a malfunction cannot be distinguished from other effects. To do so, the manufacturer must be able to provide data and/or engineering analyses that demonstrate that a properly functioning output component/system cannot be

distinguished from a malfunctioning one and that the disablement interval is limited only to that necessary for avoiding false malfunction detection.

(i)(3)(v)(B) For output component/system functional checks, the manufacturer must define the monitoring conditions for detecting malfunctions in accordance with paragraphs (c) and (d) of this section. Specifically for the idle control system, the manufacturer must define the monitoring conditions for detecting malfunctions in accordance with paragraphs (c) and (d) of this section, with the exception that functional checks must occur every time the monitoring conditions are met during the drive cycle rather than once per drive cycle as required in paragraph (c)(2) of this section.

(i)(3)(vi) *Comprehensive component MIL activation and DTC storage*.

(i)(3)(vi)(A) Except as provided for in paragraphs (i)(3)(vi)(B) and (i)(3)(vi)(C) of this section, the MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(i)(3)(vi)(B) The MIL need not be activated in conjunction with storing a MIL-on DTC for any comprehensive component if: the component or system, when malfunctioning, could not cause engine emissions to increase by 15 percent or more of the applicable FTP standard during any reasonable driving condition; or, the component or system is not used as part of the monitoring strategy for any other system or component that is required to be monitored.

(i)(3)(vi)(C) The MIL need not be activated if a malfunction has been detected in the MIL circuit that prevents the MIL from activating (e.g., burned out bulb or light-emitting diode, LED). Nonetheless, the electronic MIL status (see paragraph (k)(4)(ii) of this section) must be reported as MIL commanded-on and a MIL-on DTC must be stored.

(i)(4) Other emission control systems

(i)(4) *Other emission control system monitoring*.

(i)(4)(i) *General*. For other emission control systems that are either not addressed in paragraphs (g) through (i)(3) of this section (e.g., hydrocarbon traps, homogeneous charge compression ignition control systems), or addressed in paragraph (i)(3) of this section but not corrected or compensated for by an adaptive control system (e.g., swirl control valves), the manufacturer must submit a plan for Administrator approval of the monitoring strategy, malfunction criteria, and monitoring conditions prior to introduction on a production engine. The plan must demonstrate the effectiveness of the monitoring strategy, the malfunction criteria used, the monitoring conditions required by the monitor, and, if applicable, the determination that the requirements of paragraph (i)(4)(ii) of this section are satisfied.

(i)(4)(ii) For engines that use emission control systems that alter intake air flow or cylinder charge characteristics by actuating valve(s), flap(s), etc., in the intake air delivery system (e.g., swirl control valve systems), the manufacturer, in addition to meeting the requirements of paragraph (i)(4)(i) of this section, may elect to have the OBD system monitor the shaft to which all valves in one intake bank are physically attached rather than performing a functional check of the intake air flow, cylinder charge, or individual valve(s)/flap(s). For non-metal shafts or segmented shafts, the monitor must verify all shaft segments for proper functional response (e.g., by verifying that the segment or portion of the shaft farthest from the actuator functions properly). For systems that have more than one shaft to operate valves in multiple intake banks, the manufacturer is not required to add more than one set of detection hardware (e.g., sensor, switch) per intake bank to meet this requirement.

(i)(5) Exceptions to monitoring requirements

(i)(5) *Exceptions to OBD monitoring requirements*.

(i)(5)(i) The Administrator may revise the PM filtering performance malfunction criteria for DPFs to exclude detection of specific failure modes such as partially melted substrates, if the most reliable monitoring method developed requires it.

(i)(5)(ii) The manufacturer may disable an OBD system monitor at ambient engine start temperatures below 20 degrees Fahrenheit (low ambient temperature conditions may be determined based on intake air or engine coolant temperature at engine start) or at elevations higher than 8,000 feet above sea level. To do so, the manufacturer must submit data and/or engineering analyses that demonstrate that monitoring is unreliable during the disable conditions. A manufacturer may request that an OBD system monitor be disabled at other ambient engine

start temperatures by submitting data and/or engineering analyses demonstrating that misdiagnosis would occur at the given ambient temperatures due to their effect on the component itself (e.g., component freezing).

(i)(5)(iii) The manufacturer may disable an OBD system monitor when the fuel level is 15 percent or less of the nominal fuel tank capacity for those monitors that can be affected by low fuel level or running out of fuel (e.g., misfire detection). To do so, the manufacturer must submit data and/or engineering analyses that demonstrate that monitoring at the given fuel levels is unreliable, and that the OBD system is still able to detect a malfunction if the component(s) used to determine fuel level indicates erroneously a fuel level that causes the disablement.

(i)(5)(iv) The manufacturer may disable OBD monitors that can be affected by engine battery or system voltage levels.

(i)(5)(iv)(A) For an OBD monitor affected by low vehicle battery or system voltages, manufacturers may disable monitoring when the battery or system voltage is below 11.0 Volts. The manufacturer may use a voltage threshold higher than 11.0 Volts to disable monitors but must submit data and/or engineering analyses that demonstrate that monitoring at those voltages is unreliable and that either operation of a vehicle below the disablement criteria for extended periods of time is unlikely or the OBD system monitors the battery or system voltage and will detect a malfunction at the voltage used to disable other monitors.

(i)(5)(iv)(B) For an OBD monitor affected by high engine battery or system voltages, the manufacturer may disable monitoring when the battery or system voltage exceeds a manufacturer-defined voltage. To do so, the manufacturer must submit data and/or engineering analyses that demonstrate that monitoring above the manufacturer-defined voltage is unreliable and that either the electrical charging system/alternator warning light will be activated (or voltage gauge would be in the “red zone”) or the OBD system monitors the battery or system voltage and will detect a malfunction at the voltage used to disable other monitors.

(i)(5)(v) The manufacturer may also disable affected OBD monitors in systems designed to accommodate the installation of power take off (PTO) units provided monitors are disabled only while the PTO unit is active and the OBD readiness status (see paragraph (k)(4)(i) of this section) is cleared by the onboard computer (i.e., all monitors set to indicate “not complete” or “not ready”) while the PTO unit is activated. If monitors are so disabled and when the disablement ends, the readiness status may be restored to its state prior to PTO activation.

(i)(6) Feedback control system

(i)(6) *Feedback control system monitoring*. If the engine is equipped with feedback control of any of the systems covered in paragraphs (g), (h) and (i) of this section, then the OBD system must detect as malfunctions the conditions specified in this paragraph (i)(6) for each of the individual feedback controls.

(i)(6)(i) The OBD system must detect when the system fails to begin feedback control within a manufacturer specified time interval.

(i)(6)(ii) When any malfunction or deterioration causes open loop or limp-home operation.

(i)(6)(iii) When feedback control has used up all of the adjustment allowed by the manufacturer.

(i)(6)(iv) A manufacturer may temporarily disable monitoring for malfunctions specified in paragraph (i)(6)(iii) of this section during conditions that the specific monitor cannot distinguish robustly between a malfunctioning system and a properly operating system. To do so, the manufacturer is required to submit data and/or engineering analyses demonstrating that the individual feedback control system, when operating as designed on an engine with all emission controls working properly, routinely operates during these conditions while having used up all of the adjustment allowed by the manufacturer. In lieu of detecting, with a system specific monitor, the malfunctions specified in paragraphs (i)(6)(i) and (i)(6)(ii) of this section the OBD system may monitor the individual parameters or components that are used as inputs for individual feedback control systems provided that the monitors detect all malfunctions that meet the criteria of paragraphs (i)(6)(i) and (i)(6)(ii) of this section.

(j) Production evaluation testing

(j) *Production evaluation testing*.

(j)(1) [Reserved.]

(j)(2) *Verification of monitoring requirements*.

(j)(2)(i) Within either the first six months of the start of engine production or the first three months of the start of vehicle production, whichever is later, the manufacturer must conduct a complete evaluation of the OBD system of one or more production vehicles (test vehicles) and submit the results of the evaluation to the Administrator.

(j)(2)(ii) *Selection of test vehicles*.

(j)(2)(ii)(A) For each engine selected for monitoring system demonstration in paragraph (l) of this section, the manufacturer must evaluate one production vehicle equipped with an engine from the same engine family and rating as the demonstration engine. The vehicle selection must be approved by the Administrator.

(j)(2)(ii)(B) If the manufacturer is required to test more than one test vehicle, the manufacturer may test an engine in lieu of a vehicle for all but one of the required test vehicles.

(j)(2)(ii)(C) The requirement for submittal of data from one or more of the test vehicles may be waived if data have been submitted previously for all of the engine ratings and variants.

(j)(2)(iii) *Evaluation requirements*.

(j)(2)(iii)(A) The evaluation must demonstrate the ability of the OBD system on the selected test vehicle to detect a malfunction, activate the MIL, and, where applicable, store an appropriate DTC readable by a scan tool when a malfunction is present and the monitoring conditions have been satisfied for each individual monitor required by this section.

(j)(2)(iii)(B) The evaluation must verify that the malfunction of any component used to enable another OBD monitor but that does not itself result in MIL activation (e.g., fuel level sensor) will not inhibit the ability of other OBD monitors to detect malfunctions properly.

(j)(2)(iii)(C) The evaluation must verify that the software used to track the numerator and denominator for the purpose of determining in-use monitoring frequency increments as required by paragraph (d)(2) of this section.

(j)(2)(iii)(D) Malfunctions may be implanted mechanically or simulated electronically, but internal onboard computer hardware or software changes shall not be used to simulate malfunctions. For monitors that are required to indicate a malfunction before emissions exceed an emission threshold, manufacturers are not required to use malfunctioning components/systems set exactly at their malfunction criteria limits. Emission testing is not required to confirm that the malfunction is detected before the appropriate emission thresholds are exceeded.

(j)(2)(iii)(E) The manufacturer must submit a proposed test plan for approval prior to performing evaluation testing. The test plan must identify the method used to induce a malfunction for each monitor.

(j)(2)(iii)(F) If the demonstration of a specific monitor cannot be reasonably performed without causing physical damage to the test vehicle (e.g., onboard computer internal circuit malfunctions), the manufacturer may omit the specific demonstration.

(j)(2)(iii)(G) For evaluation of test vehicles selected in accordance with paragraph (j)(2)(ii) of this section, the manufacturer is not required to demonstrate monitors that were demonstrated prior to certification as required in paragraph (l) of this section.

(j)(2)(iv) The manufacturer must submit a report of the results of all testing conducted as required by paragraph (j)(2) of this section. The report must identify the method used to induce a malfunction in each monitor, the MIL activation status, and the DTC(s) stored.

(j)(3) *Verification of in-use monitoring performance ratios*.

(j)(3)(i) The manufacturer must collect and report in-use monitoring performance data representative of production vehicles (i.e., engine rating and chassis application combination). The manufacturer must collect and report the data to the Administrator within 12 months after the first production vehicle was first introduced into commerce.

(j)(3)(ii) The manufacturer must separate production vehicles into the monitoring performance groups and submit data that represents each of these groups. The groups shall be based on the following criteria:

(j)(3)(ii)(A) Emission control system architecture. All engines that use the same or similar emissions control system architecture (e.g., EGR with DPF and SCR; EGR with DPF and NOx

adsorber; EGR with DPF-only) and associated monitoring system would be in the same emission architecture category.

(j)(3)(ii)(B) Vehicle application type. Within an emission architecture category, engines shall be separated into one of three vehicle application types: engines intended primarily for line-haul chassis applications, engines intended primarily for urban delivery chassis applications, and all other engines.

(j)(3)(iii) The manufacturer may use an alternative grouping method to collect representative data. To do so, the manufacturer must show that the alternative groups include production vehicles using similar emission controls, OBD strategies, monitoring condition calibrations, and vehicle application driving/usage patterns such that they are expected to have similar in-use monitoring performance. The manufacturer will still be required to submit one set of data for each of the alternative groups.

(j)(3)(iv) For each monitoring performance group, the data must include all of the in-use performance tracking data (i.e., all numerators, denominators, the general denominator, and the ignition cycle counter), the date the data were collected, the odometer reading, the VIN, and the calibration ID.

(j)(3)(v) The manufacturer must submit a plan to the Administrator that details the types of production vehicles in each monitoring performance group, the number of vehicles per group to be sampled, the sampling method, the timeline to collect the data, and the reporting format. The plan must provide for effective collection of data from, at least, 15 vehicles per monitoring performance group and provide for data that represent a broad range of temperature conditions. The plan shall not, by design, exclude or include specific vehicles in an attempt to collect data only from vehicles expected to have the highest in-use performance ratios.

(j)(3)(vi) The 12 month deadline for reporting may be extended to 18 months if the manufacturer can show that the delay is justified. In such a case, an interim report of progress to date must be submitted within the 12 month deadline.

(k) Standardization requirements

(k) *Standardization requirements*.

(k)(1) *Reference materials*. The OBD system must conform with the following Society of Automotive Engineers (SAE) standards and/or the following International Standards Organization (ISO) standards. The following documents are incorporated by reference, see §86.1:

(k)(1)(i) SAE material. Copies of these materials may be obtained from the Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096–0001.

(k)(1)(i)(A) SAE J1930 “Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms – Equivalent to ISO/TR 15031-2:April 30, 2002,” April 2002.

(k)(1)(i)(B) SAE J1939 “Recommended Practice for a Serial Control and Communications Vehicle Network” and the associated subparts included in SAE HS-1939, “Truck and Bus Control and Communications Network Standards Manual,” 2006 Edition.

(k)(1)(i)(C) [Reserved.]

(k)(1)(i)(D) SAE J1978 “OBD II Scan Tool – Equivalent to ISO/DIS 15031-4: December 14, 2001,” April 2002.

(k)(1)(i)(E) SAE J1979 “E/E Diagnostic Test Modes – Equivalent to ISO/DIS 15031-5:April 30, 2002,” April 2002.

(k)(1)(i)(F) SAE J2012 “Diagnostic Trouble Code Definitions – Equivalent to ISO/DIS 15031-6:April 30, 2002,” April 2002.

(k)(1)(i)(G) SAE J2403 “Medium/Heavy-Duty E/E Systems Diagnosis Nomenclature,” August 2004.

(k)(1)(i)(H) SAE J2534 “Recommended Practice for Pass-Thru Vehicle Reprogramming,” February 2002.

(k)(1)(ii) ISO materials. Copies of these materials may be obtained from the International Organization for Standardization, Case Postale 56, CH–1211 Geneva 20, Switzerland.

(k)(1)(ii)(A) ISO 15765-4:2001 “Road Vehicles-Diagnostics on Controller Area Network (CAN) - Part 4: Requirements for emission-related systems,” December 2001.

(k)(2) The manufacturer defined data link connector must be accessible to a trained service technician.

(k)(3) [Reserved.]

(k)(4) *Required emission related functions*. The following functions must be implemented and must be accessible by, at a minimum, a manufacturer scan tool:

(k)(4)(i) *Ready status*. The OBD system must indicate "complete" or "not complete" for each of the installed monitored components and systems identified in paragraphs (g), (h) with the exception of (h)(4), and (i)(3) of this section. All components or systems identified in paragraphs (h)(1), (h)(2), or (i)(3) of this section that are monitored continuously must always indicate "complete." Components or systems that are not subject to being monitored continuously must immediately indicate "complete" upon the respective monitor(s) being executed fully and determining that the component or system is not malfunctioning. A component or system must also indicate "complete" if, after the requisite number of decisions necessary for determining MIL status has been executed fully, the monitor indicates a malfunction of the component or system. The status for each of the monitored components or systems must indicate "not complete" whenever diagnostic memory has been cleared or erased by a means other than that allowed in paragraph (b) of this section. Normal vehicle shut down (i.e., key-off/engine-off) shall not cause the status to indicate "not complete."

(k)(4)(i)(A) The manufacturer may request that the ready status for a monitor be set to indicate "complete" without the monitor having completed if monitoring is disabled for a multiple number of drive cycles due to the continued presence of extreme operating conditions (e.g., cold ambient temperatures, high altitudes). Any such request must specify the conditions for monitoring system disablement and the number of drive cycles that would pass without monitor completion before ready status would be indicated as "complete."

(k)(4)(i)(B) For the evaporative system monitor, the ready status must be set in accordance with this paragraph (k)(4)(i) when both the functional check of the purge valve and, if applicable, the leak detection monitor of the hole size specified in paragraph (h)(7)(ii)(B) of this section indicate that they are complete.

(k)(4)(i)(C) If the manufacturer elects to indicate ready status through the MIL in the key-on/engine-off position as provided for in paragraph (b)(1)(iii) of this section, the ready status must be indicated in the following manner: If the ready status for all monitored components or systems is "complete," the MIL shall remain continuously activated in the key-on/engine-off position for at least 10-20 seconds. If the ready status for one or more of the monitored components or systems is "not complete," after at least 5 seconds of operation in the key-on/engine-off position with the MIL activated continuously, the MIL shall blink once per second for 5-10 seconds. The data stream value for MIL status as required in paragraph (k)(4)(ii) of this section must indicate "commanded off" during this sequence unless the MIL has also been "commanded on" for a detected malfunction.

(k)(4)(ii) *Data stream*. The following signals must be made available on demand through the data link connector. The actual signal value must always be used instead of a limp home value.

(k)(4)(ii)(A) *For gasoline engines*.

(k)(4)(ii)(A)(1) Calculated load value, engine coolant temperature, engine speed, vehicle speed, and time elapsed since engine start.

(k)(4)(ii)(A)(2) Absolute load, fuel level (if used to enable or disable any other monitors), barometric pressure (directly measured or estimated), engine control module system voltage, and commanded equivalence ratio.

(k)(4)(ii)(A)(3) Number of stored MIL-on DTCs, catalyst temperature (if directly measured or estimated for purposes of enabling the catalyst monitor(s)), monitor status (i.e., disabled for the rest of this drive cycle, complete this drive cycle, or not complete this drive cycle) since last engine shut-off for each monitor used for ready status, distance traveled (or engine run time for engines not using vehicle speed information) while MIL activated, distance traveled (or engine run time for engines not using vehicle speed information) since DTC memory last erased, and number of warm-up cycles since DTC memory last erased, OBD requirements to which the engine is certified (e.g., California OBD, EPA OBD, European OBD, non-OBD) and MIL status (i.e., commanded-on or commanded-off).

(k)(4)(ii)(B) *For diesel engines*.

(k)(4)(ii)(B)(1) Calculated load (engine torque as a percentage of maximum torque available at the current engine speed), driver's demand engine torque (as a percentage of

maximum engine torque), actual engine torque (as a percentage of maximum engine torque), reference engine maximum torque, reference maximum engine torque as a function of engine speed (suspect parameter numbers (SPN) 539 through 543 defined by SAE J1939 within parameter group number (PGN) 65251 for engine configuration), engine coolant temperature, engine oil temperature (if used for emission control or any OBD monitors), engine speed, and time elapsed since engine start.

(k)(4)(ii)(B)(2) Fuel level (if used to enable or disable any other monitors), vehicle speed (if used for emission control or any OBD monitors), barometric pressure (directly measured or estimated), and engine control module system voltage.

(k)(4)(ii)(B)(3) Number of stored MIL-on DTCs, monitor status (i.e., disabled for the rest of this drive cycle, complete this drive cycle, or not complete this drive cycle) since last engine shut-off for each monitor used for ready status, distance traveled (or engine run time for engines not using vehicle speed information) while MIL activated, distance traveled (or engine run time for engines not using vehicle speed information) since DTC memory last erased, number of warm-up cycles since DTC memory last erased, OBD requirements to which the engine is certified (e.g., California OBD, EPA OBD, European OBD, non-OBD), and MIL status (i.e., commanded-on or commanded-off).

(k)(4)(ii)(B)(4) NOx NTE control area status (i.e., inside control area, outside control area, inside manufacturer-specific NOx NTE carve-out area, or deficiency active area) and PM NTE control area status (i.e., inside control area, outside control area, inside manufacturer-specific PM NTE carve-out area, or deficiency active area).

(k)(4)(ii)(B)(5) For purposes of the calculated load and torque parameters in paragraph (k)(4)(ii)(B)(*1*) of this section, manufacturers must report the most accurate values that are calculated within the applicable electronic control unit (e.g., the engine control module). Most accurate, in this context, must be of sufficient accuracy, resolution, and filtering to be used for the purposes of in-use emission testing with the engine still in a vehicle (e.g., using portable emission measurement equipment).

(k)(4)(ii)(C) *For all engines so equipped*.

(k)(4)(ii)(C)(1) Absolute throttle position, relative throttle position, fuel control system status (e.g., open loop, closed loop), fuel trim, fuel pressure, ignition timing advance, fuel injection timing, intake air/manifold temperature, engine intercooler temperature, manifold absolute pressure, air flow rate from mass air flow sensor, secondary air status (upstream, downstream, or atmosphere), ambient air temperature, commanded purge valve duty cycle/position, commanded EGR valve duty cycle/position, actual EGR valve duty cycle/position, EGR error between actual and commanded, PTO status (active or not active), redundant absolute throttle position (for electronic throttle or other systems that utilize two or more sensors), absolute pedal position, redundant absolute pedal position, commanded throttle motor position, fuel rate, boost pressure, commanded/target boost pressure, turbo inlet air temperature, fuel rail pressure, commanded fuel rail pressure, DPF inlet pressure, DPF inlet temperature, DPF outlet pressure, DPF outlet temperature, DPF delta pressure, exhaust pressure sensor output, exhaust gas temperature sensor output, injection control pressure, commanded injection control pressure, turbocharger/turbine speed, variable geometry turbo position, commanded variable geometry turbo position, turbocharger compressor inlet temperature, turbocharger compressor inlet pressure, turbocharger turbine inlet temperature, turbocharger turbine outlet temperature, waste gate valve position, and glow plug lamp status.

(k)(4)(ii)(C)(2) Oxygen sensor output, air/fuel ratio sensor output, NOx sensor output, and evaporative system vapor pressure.

(k)(4)(iii) *Freeze frame*.

(k)(4)(iii)(A) “Freeze frame” information required to be stored pursuant to paragraphs (b)(2)(iv), (h)(1)(iv)(D), and (h)(2)(vi) of this section must be made available on demand through the data link connector.

(k)(4)(iii)(B) “Freeze frame” conditions must include the DTC that caused the data to be stored along with all of the signals required in paragraphs (k)(4)(ii)(A)(*1*) or (k)(4)(ii)(B)(*1*) of this section. Freeze frame conditions must also include all of the signals required on the engine in paragraphs (k)(4)(ii)(A)(*2*) and (k)(4)(ii)(B)(*2*) of this section, and paragraph (k)(4)(ii)(C)(*1*) of this

section that are used for diagnostic or control purposes in the specific monitor or emission-critical powertrain control unit that stored the DTC.

(k)(4)(iii)(C) Only one frame of data is required to be recorded. The manufacturer may choose to store additional frames provided that at least the required frame can be read by, at a minimum, a manufacturer scan tool.

(k)(4)(iv) *Diagnostic trouble codes*.

(k)(4)(iv)(A) For all monitored components and systems, any stored pending, MIL-on, and previous-MIL-on DTCs must be made available through the diagnostic connector.

(k)(4)(iv)(B) The stored DTC must, to the extent possible, pinpoint the probable cause of the malfunction or potential malfunction. To the extent feasible, the manufacturer must use separate DTCs for every monitor where the monitor and repair procedure or probable cause of the malfunction is different. In general, rationality and functional checks must use different DTCs than the respective circuit integrity checks. Additionally, input component circuit integrity checks must use different DTCs for distinct malfunctions (e.g., out-of-range low, out-of-range high, open circuit).

(k)(4)(iv)(C) The manufacturer must use appropriate standard-defined DTCs whenever possible. With Administrator approval, the manufacturer may use manufacturer-defined DTCs in accordance with the applicable standard's specifications. To do so, the manufacturer must be able to show a lack of available standard-defined DTCs, uniqueness of the monitor or monitored component, expected future usage of the monitor or component, and estimated usefulness in providing additional diagnostic and repair information to service technicians. Manufacturer-defined DTCs must be used in a consistent manner (i.e., the same DTC shall not be used to represent two different failure modes) across a manufacturer's entire product line.

(k)(4)(iv)(D) A pending or MIL-on DTC (as required in paragraphs (g) through (i) of this section) must be stored and available to, at a minimum, a manufacturer scan tool within 10 seconds after a monitor has determined that a malfunction or potential malfunction has occurred. A permanent DTC must be stored and available to, at a minimum, a manufacturer scan tool no later than the end of an ignition cycle in which the corresponding MIL-on DTC that caused MIL activation has been stored.

(k)(4)(iv)(E) Pending DTCs for all components and systems (including those monitored continuously and non-continuously) must be made available through the diagnostic connector. A manufacturer using alternative statistical protocols for MIL activation as allowed in paragraph (b)(2)(iii) of this section must submit the details of their protocol for setting pending DTCs. The protocol must be, overall, equivalent to the requirements of this paragraph (k)(4)(iv)(E) and provide service technicians with a quick and accurate indication of a potential malfunction.

(k)(4)(iv)(F) Permanent DTC for all components and systems must be made available through the diagnostic connector in a format that distinguishes permanent DTCs from pending DTCs, MIL-on DTCs, and previous-MIL-on DTCs. A MIL-on DTC must be stored as a permanent DTC no later than the end of the ignition cycle and subsequently at all times that the MIL-on DTC is commanding the MIL on. Permanent DTCs must be stored in non-volatile random access memory (NVRAM) and shall not be erasable by any scan tool command or by disconnecting power to the on-board computer. Permanent DTCs must be erasable if the engine control module is reprogrammed and the ready status described in paragraph (k)(4)(i) of this section for all monitored components and systems are set to "not complete." The OBD system must have the ability to store a minimum of four current MIL-on DTCs as permanent DTCs in NVRAM. If the number of MIL-on DTCs currently commanding activation of the MIL exceeds the maximum number of permanent DTCs that can be stored, the OBD system must store the earliest detected MIL-on DTC as permanent DTC. If additional MIL-on DTCs are stored when the maximum number of permanent DTCs is already stored in NVRAM, the OBD system shall not replace any existing permanent DTC with the additional MIL-on DTCs.

(k)(4)(v) *Test results*.

(k)(4)(v)(A) Except as provided for in paragraph (k)(4)(v)(G) of this section, for all monitored components and systems identified in paragraphs (g) and (h) of this section, results of the most recent monitoring of the components and systems and the test limits established for monitoring the respective components and systems must be stored and available through the data link.

(k)(4)(v)(B) The test results must be reported such that properly functioning components and systems (e.g., “passing” systems) do not store test values outside of the established test limits. Test limits must include both minimum and maximum acceptable values and must be defined so that a test result equal to either test limit is a “passing” value, not a “failing” value.

(k)(4)(v)(C) [Reserved.]

(k)(4)(v)(D) The test results must be stored until updated by a more recent valid test result or the DTC memory of the OBD system computer is cleared. Upon DTC memory being cleared, test results reported for monitors that have not yet completed with valid test results since the last time the fault memory was cleared must report values of zero for the test result and test limits.

(k)(4)(v)(E) All test results and test limits must always be reported and the test results must be stored until updated by a more recent valid test result or the DTC memory of the OBD system computer is cleared.

(k)(4)(v)(F) The OBD system must store and report unique test results for each separate monitor.

(k)(4)(v)(G) The requirements of this paragraph (k)(4)(v) do not apply to continuous fuel system monitoring, cold start emission reduction strategy monitoring, and continuous circuit monitoring.

(k)(4)(vi) *Software calibration identification (CAL ID)*. On all engines, a single software calibration identification number (CAL ID) for each monitor or emission critical control unit(s) must be made available through the data link connector. A unique CAL ID must be used for every emission-related calibration and/or software set having at least one bit of different data from any other emission-related calibration and/or software set. Control units coded with multiple emission or diagnostic calibrations and/or software sets must indicate a unique CAL ID for each variant in a manner that enables an off-board device to determine which variant is being used by the vehicle. Control units that use a strategy that will result in MIL activation if the incorrect variant is used (e.g., control units that contain variants for manual and automatic transmissions but will activate the MIL if the selected variant does not match the type of transmission mated to the engine) are not required to use unique CAL IDs.

(k)(4)(vii) *Software calibration verification number (CVN)*.

(k)(4)(vii)(A) All engines must use an algorithm to calculate a single calibration verification number (CVN) that verifies the on-board computer software integrity for each monitor or emission critical control unit that is electronically reprogrammable. The CVN must be made available through the data link connector. The CVN must indicate whether the emission-related software and/or calibration data are valid and applicable for the given vehicle and CAL ID.

(k)(4)(vii)(B) The CVN algorithm used to calculate the CVN must be of sufficient complexity that the same CVN is difficult to achieve with modified calibration values.

(k)(4)(vii)(C) The CVN must be calculated at least once per drive cycle and stored until the CVN is subsequently updated. Except for immediately after a reprogramming event or a non-volatile memory clear or for the first 30 seconds of engine operation after a volatile memory clear or battery disconnect, the stored value must be made available through the data link connector to, at a minimum, a manufacturer scan tool. The stored CVN value shall not be erased when DTC memory is erased or during normal vehicle shut down (i.e., key-off/engine-off).

(k)(4)(vii)(D) [Reserved.]

(k)(4)(viii) *Vehicle identification number (VIN)*.

(k)(4)(viii)(A) All vehicles must have the vehicle identification number (VIN) available through the data link connector to, at a minimum, a manufacturer scan tool. Only one electronic control unit per vehicle may report the VIN to a scan tool.

(k)(4)(viii)(B) If the VIN is reprogrammable, all emission-related diagnostic information identified in paragraph (k)(4)(ix)(A) of this section must be erased in conjunction with reprogramming of the VIN.

(k)(4)(ix) *Erasure of diagnostic information*.

(k)(4)(ix)(A) For purposes of this paragraph (k)(4)(ix), “emission-related diagnostic information” includes all of the following: ready status as required by paragraph (k)(4)(i) of this section; data stream information as required by paragraph (k)(4)(ii) of this section including the number of stored MIL-on DTCs, distance traveled while MIL activated, number of warm-up cycles since DTC memory last erased, and distance traveled since DTC memory last erased; freeze

frame information as required by paragraph (k)(4)(iii) of this section; pending, MIL-on, and previous-MIL-on DTCs as required by paragraph (k)(4)(iv) of this section; and, test results as required by paragraph (k)(4)(v) of this section.

(k)(4)(ix)(B) For all engines, the emission-related diagnostic information must be erased if commanded by any scan tool and may be erased if the power to the on-board computer is disconnected. If any of the emission-related diagnostic information is commanded to be erased by any scan tool, all emission-related diagnostic information must be erased from all diagnostic or emission critical control units. The OBD system shall not allow a scan tool to erase a subset of the emission-related diagnostic information (e.g., the OBD system shall not allow a scan tool to erase only one of three stored DTCs or only information from one control unit without erasing information from the other control unit(s)).

(k)(5) *In-use performance ratio tracking requirements*.

(k)(5)(i) For each monitor required in paragraphs (g) through (i) of this section to separately report an in-use performance ratio, manufacturers must implement software algorithms to report a numerator and denominator.

(k)(5)(ii) For the numerator, denominator, general denominator, and ignition cycle counters required by paragraph (e) of this section, the following numerical value specifications apply:

(k)(5)(ii)(A) Each number shall have a minimum value of zero and a maximum value of 65,535 with a resolution of one.

(k)(5)(ii)(B) Each number shall be reset to zero only when a non-volatile random access memory (NVRAM) reset occurs (e.g., reprogramming event) or, if the numbers are stored in keep-alive memory (KAM), when KAM is lost due to an interruption in electrical power to the control unit (e.g., battery disconnect). Numbers shall not be reset to zero under any other circumstances including when a scan tool command to clear DTCs or reset KAM is received.

(k)(5)(ii)(C) To avoid overflow problems, if either the numerator or denominator for a specific component reaches the maximum value of 65,535 ±2, both numbers shall be divided by two before either is incremented again.

(k)(5)(ii)(D) To avoid overflow problems, if the ignition cycle counter reaches the maximum value of 65,535 ±2, the ignition cycle counter shall rollover and increment to zero on the next ignition cycle.

(k)(5)(ii)(E) To avoid overflow problems, if the general denominator reaches the maximum value of 65,535 ±2, the general denominator shall rollover and increment to zero on the next drive cycle that meets the general denominator definition.

(k)(5)(ii)(F) If a vehicle is not equipped with a component (e.g., oxygen sensor bank 2, secondary air system), the corresponding numerator and denominator for that specific component shall always be reported as zero.

(k)(5)(iii) For the ratio required by paragraph (e) of this section, the following numerical value specifications apply:

(k)(5)(iii)(A) The ratio shall have a minimum value of zero and a maximum value of 7.99527 with a resolution of 0.000122.

(k)(5)(iii)(B) The ratio for a specific component shall be considered to be zero whenever the corresponding numerator is equal to zero and the corresponding denominator is not zero.

(k)(5)(iii)(C) The ratio for a specific component shall be considered to be the maximum value of 7.99527 if the corresponding denominator is zero or if the actual value of the numerator divided by the denominator exceeds the maximum value of 7.99527.

(k)(6) *Engine run time tracking requirements*.

(k)(6)(i) For all gasoline and diesel engines, the manufacturer must implement software algorithms to track and report individually the amount of time the engine has been operated in the following conditions:

(k)(6)(i)(A) Total engine run time.

(k)(6)(i)(B) Total idle run time (with “idle” defined as accelerator pedal released by the driver, vehicle speed less than or equal to one mile per hour, engine speed greater than or equal to 50 to 150 rpm below the normal, warmed-up idle speed (as determined in the drive position for vehicles equipped with an automatic transmission), and power take-off not active).

(k)(6)(i)(C) Total run time with power take off active.

(k)(6)(ii) For each counter specified in paragraph (k)(6)(i) of this section, the following numerical value specifications apply:

(k)(6)(ii)(A) Each number shall be a four-byte value with a minimum value of zero, a resolution of one second per bit, and an accuracy of +/- ten seconds per drive cycle.

(k)(6)(ii)(B) Each number shall be reset to zero only when a non-volatile memory reset occurs (e.g., reprogramming event). Numbers shall not be reset to zero under any other circumstances including when a scan tool (generic or enhanced) command to clear fault codes or reset KAM is received.

(k)(6)(ii)(C) To avoid overflow problems, if any of the individual counters reach the maximum value, all counters shall be divided by two before any are incremented again.

(k)(6)(ii)(D) The counters shall be made available to, at a minimum, a manufacturer scan tool and may be rescaled when transmitted from a resolution of one second per bit to no more than three minutes per bit.

(l) Monitoring system demonstration requirements for certification

(l) *Monitoring system demonstration requirements for certification*.

(l)(1) General

(l)(1) *General*.

(l)(1)(i) The manufacturer must submit emissions test data from one or more durability demonstration test engines (test engines).

(l)(1)(ii) The Administrator may approve other demonstration protocols if the manufacturer can provide comparable assurance that the malfunction criteria are chosen based on meeting the malfunction criteria requirements and that the timeliness of malfunction detection is within the constraints of the applicable monitoring requirements.

(l)(1)(iii) For flexible fuel engines capable of operating on more than one fuel or fuel combinations, the manufacturer must submit a plan for providing emission test data. The plan must demonstrate that testing will represent properly the expected in-use fuel or fuel combinations.

(l)(2) Selection of test engines

(l)(2) *Selection of test engines*.

(l)(2)(i) Prior to submitting any applications for certification for a model year, the manufacturer must notify the Administrator regarding the planned engine families and engine ratings within each family for that model year. The Administrator will select the engine family(ies) and the specific engine rating within the engine family(ies) that the manufacturer shall use as demonstration test engines. The selection of test vehicles for production evaluation testing as specified in paragraph (j)(2) of this section may take place during this selection process.

(l)(2)(ii) The manufacturer must provide emissions test data from the OBD parent rating as defined in paragraph (o)(1) of this section.

(l)(2)(iii) For the test engine, the manufacturer must use an engine aged for a minimum of 125 hours fitted with exhaust aftertreatment emission controls aged to be representative of useful life aging. The manufacturer is required to submit a description of the accelerated aging process and/or supporting data. The process and/or data must demonstrate assurance that deterioration of the exhaust aftertreatment emission controls is stabilized sufficiently such that it represents emission control performance at the end of the useful life.

(l)(3) Required testing

(l)(3) *Required testing*. Except as otherwise described in this paragraph (l)(3), the manufacturer must perform single malfunction testing based on the applicable test with the components/systems set at their malfunction criteria limits as determined by the manufacturer for meeting the emissions thresholds required in paragraphs (g), (h), and (i) of this section.

(l)(3)(i) *Required testing for diesel-fueled/compression ignition engines*.

(l)(3)(i)(A) *Fuel system*. The manufacturer must perform a separate test for each malfunction limit established by the manufacturer for the fuel system parameters (e.g., fuel pressure, injection timing) specified in paragraphs (g)(1)(ii)(A) through (g)(1)(ii)(C) of this section. When performing a test for a specific parameter, the fuel system must be operating at the

malfunction criteria limit for the applicable parameter only. All other parameters must be operating with normal characteristics. In conducting the fuel system demonstration tests, the manufacturer may use computer modifications to cause the fuel system to operate at the malfunction limit if the manufacturer can demonstrate that the computer modifications produce test results equivalent to an induced hardware malfunction.

(l)(3)(i)(B) [Reserved.]

(l)(3)(i)(C) *EGR system*. The manufacturer must perform a separate test for each malfunction limit established by the manufacturer for the EGR system parameters (e.g., low flow, high flow, slow response) specified in paragraphs (g)(3)(ii)(A) through (g)(3)(ii)(C) of this section and in (g)(3)(ii)(E) of this section. In conducting the EGR system slow response demonstration tests, the manufacturer may use computer modifications to cause the EGR system to operate at the malfunction limit if the manufacturer can demonstrate that the computer modifications produce test results equivalent to an induced hardware malfunction.

(l)(3)(i)(D) *Turbo boost control system*. The manufacturer must perform a separate test for each malfunction limit established by the manufacturer for the turbo boost control system parameters (e.g., underboost, overboost, response) specified in paragraphs (g)(4)(ii)(A) through (g)(4)(ii)(C) of this section and in (g)(4)(ii)(E) of this section.

(l)(3)(i)(E) *NMHC catalyst*. The manufacturer must perform a separate test for each monitored NMHC catalyst(s). The catalyst(s) being evaluated must be deteriorated to the applicable malfunction limit established by the manufacturer for the monitoring required by paragraph (g)(5)(ii)(A) of this section and using methods established by the manufacturer in accordance with paragraph (l)(7) of this section. For each monitored NMHC catalyst(s), the manufacturer must also demonstrate that the OBD system will detect a catalyst malfunction with the catalyst at its maximum level of deterioration (i.e., the substrate(s) completely removed from the catalyst container or “empty” can). Emissions data are not required for the empty can demonstration.

(l)(3)(i)(F) *NOx catalyst*. The manufacturer must perform a separate test for each monitored NOx catalyst(s) (e.g., SCR catalyst). The catalyst(s) being evaluated must be deteriorated to the applicable malfunction criteria established by the manufacturer for the monitoring required by paragraphs (g)(6)(ii)(A) and (g)(6)(ii)(B) of this section and using methods established by the manufacturer in accordance with paragraph (l)(7) of this section. For each monitored NOx catalyst(s), the manufacturer must also demonstrate that the OBD system will detect a catalyst malfunction with the catalyst at its maximum level of deterioration (i.e., the substrate(s) completely removed from the catalyst container or “empty” can). Emissions data are not required for the empty can demonstration.

(l)(3)(i)(G) *NOx adsorber*. The manufacturer must perform a test using a NOx adsorber(s) deteriorated to the applicable malfunction limit established by the manufacturer for the monitoring required by paragraph (g)(7)(ii)(A) of this section. The manufacturer must also demonstrate that the OBD system will detect a NOx adsorber malfunction with the NOx adsorber at its maximum level of deterioration (i.e., the substrate(s) completely removed from the container or “empty” can). Emissions data are not required for the empty can demonstration.

(l)(3)(i)(H) *Diesel particulate filter*. The manufacturer must perform a separate test using a DPF deteriorated to the applicable malfunction limits established by the manufacturer for the monitoring required by paragraphs (g)(8)(ii)(A), (g)(8)(ii)(B), and (g)(8)(ii)(D) of this section. The manufacturer must also demonstrate that the OBD system will detect a DPF malfunction with the DPF at its maximum level of deterioration (i.e., the filter(s) completely removed from the filter container or “empty” can). Emissions data are not required for the empty can demonstration.

(l)(3)(i)(I) *Exhaust gas sensor*. The manufacturer must perform a separate test for each malfunction limit established by the manufacturer for the monitoring required in paragraphs (g)(9)(ii)(A), (g)(9)(iii)(A), and (g)(9)(iv)(A) of this section. When performing a test, all exhaust gas sensors used for the same purpose (e.g., for the same feedback control loop, for the same control feature on parallel exhaust banks) must be operating at the malfunction criteria limit for the applicable parameter only. All other exhaust gas sensor parameters must be operating with normal characteristics.

(l)(3)(i)(J) *VVT system*. The manufacturer must perform a separate test for each malfunction limit established by the manufacturer for the monitoring required in paragraphs (g)(10)(ii)(A) and

(g)(10)(ii)(B) of this section. In conducting the VVT system demonstration tests, the manufacturer may use computer modifications to cause the VVT system to operate at the malfunction limit if the manufacturer can demonstrate that the computer modifications produce test results equivalent to an induced hardware malfunction.

(l)(3)(i)(K) For each of the testing requirements of this paragraph (l)(3)(i), if the manufacturer has established that only a functional check is required because no failure or deterioration of the specific tested system could result in an engine's emissions exceeding the applicable emissions thresholds, the manufacturer is not required to perform a demonstration test; however, the manufacturer is required to provide the data and/or engineering analysis used to determine that only a functional test of the system(s) is required.

(l)(3)(ii) *Required testing for gasoline-fueled/spark-ignition engines*.

(l)(3)(ii)(A) *Fuel system*. For engines with adaptive feedback based on the primary fuel control sensor(s), the manufacturer must perform a test with the adaptive feedback based on the primary fuel control sensor(s) at the rich limit(s) and a test at the lean limit(s) established by the manufacturer as required by paragraph (h)(1)(ii)(A) of this section to detect a malfunction before emissions exceed applicable emissions thresholds. For engines with feedback based on a secondary fuel control sensor(s) and subject to the malfunction criteria in paragraph (h)(1)(ii)(A) of this section, the manufacturer must perform a test with the feedback based on the secondary fuel control sensor(s) at the rich limit(s) and a test at the lean limit(s) established by the manufacturer as required by paragraph (h)(1)(ii)(A) of this section to detect a malfunction before emissions exceed the applicable emissions thresholds. For other fuel metering or control systems, the manufacturer must perform a test at the criteria limit(s). For purposes of fuel system testing as required by this paragraph (l)(3)(ii)(A), the malfunction(s) induced may result in a uniform distribution of fuel and air among the cylinders. Non uniform distribution of fuel and air used to induce a malfunction shall not cause misfire. In conducting the fuel system demonstration tests, the manufacturer may use computer modifications to cause the fuel system to operate at the malfunction limit. To do so, the manufacturer must be able to demonstrate that the computer modifications produce test results equivalent to an induced hardware malfunction.

(l)(3)(ii)(B) *Misfire*. The manufacturer must perform a test at the malfunction criteria limit specified in paragraph (h)(2)(ii)(B) of this section.

(l)(3)(ii)(C) *EGR system*. The manufacturer must perform a test at each flow limit calibrated to the malfunction criteria specified in paragraphs (h)(3)(ii)(A) and (h)(3)(ii)(B) of this section.

(l)(3)(ii)(D) *Cold start emission reduction strategy*. The manufacturer must perform a test at the malfunction criteria for each component monitored according to paragraph (h)(4)(ii)(A) of this section.

(l)(3)(ii)(E) *Secondary air system*. The manufacturer must perform a test at each flow limit calibrated to the malfunction criteria specified in paragraphs (h)(5)(ii)(A) and (h)(5)(ii)(B) of this section.

(l)(3)(ii)(F) *Catalyst*. The manufacturer must perform a test using a catalyst system deteriorated to the malfunction criteria specified in paragraph (h)(6)(ii) of this section using methods established by the manufacturer in accordance with paragraph (l)(7)(ii) of this section. The manufacturer must also demonstrate that the OBD system will detect a catalyst system malfunction with the catalyst system at its maximum level of deterioration (i.e., the substrate(s) completely removed from the catalyst container or "empty" can). Emission data are not required for the empty can demonstration.

(l)(3)(ii)(G) *Exhaust gas sensor*. The manufacturer must perform a test with all primary exhaust gas sensors used for fuel control simultaneously possessing a response rate deteriorated to the malfunction criteria limit specified in paragraph (h)(8)(ii)(A) of this section. The manufacturer must also perform a test for any other primary or secondary exhaust gas sensor parameter under parargraphs (h)(8)(ii)(A) and (h)(8)(iii)(A) of this section that can cause engine emissions to exceed the applicable emissions thresholds (e.g., shift in air/fuel ratio at which oxygen sensor switches, decreased amplitude). When performing additional test(s), all primary and secondary (if applicable) exhaust gas sensors used for emission control must be operating at the malfunction criteria limit for the applicable parameter only. All other primary and secondary exhaust gas sensor parameters must be operating with normal characteristics.

(l)(3)(ii)(H) *VVT system*. The manufacturer must perform a test at each target error limit and slow response limit calibrated to the malfunction criteria specified in (h)(9)(ii)(A) and (h)(9)(ii)(B) of this section. In conducting the VVT system demonstration tests, the manufacturer may use computer modifications to cause the VVT system to operate at the malfunction limit. To do so, the manufacturer must be able to demonstrate that the computer modifications produce test results equivalent to an induced hardware malfunction.

(l)(3)(ii)(I) For each of the testing requirements of this paragraph (l)(3)(ii), if the manufacturer has established that only a functional check is required because no failure or deterioration of the specific tested system could cause an engine's emissions to exceed the applicable emissions thresholds, the manufacturer is not required to perform a demonstration test; however the manufacturer is required to provide the data and/or engineering analyses used to determine that only a functional test of the system(s) is required.

(l)(3)(iii) *Required testing for all engines*.

(l)(3)(iii)(A) Other emission control systems. The manufacturer must conduct demonstration tests for all other emission control components (e.g., hydrocarbon traps, adsorbers) designed and calibrated to a malfunction limit based on an emissions threshold based on the requirements of paragraph (i)(4) of this section.

(l)(3)(iii)(B) For each of the testing requirements of paragraph (l)(3)(iii)(A) of this section, if the manufacturer has established that only a functional check is required because no failure or deterioration of the specific tested system could result in an engine's emissions exceeding the applicable emissions thresholds, the manufacturer is not required to perform a demonstration test; however, the manufacturer is required to provide the data and/or engineering analysis used to determine that only a functional test of the system(s) is required.

(l)(3)(iv) The manufacturer may electronically simulate deteriorated components but shall not make any engine control unit modifications when performing demonstration tests unless approved by the Administrator. All equipment necessary to duplicate the demonstration test must be made available to the Administrator upon request.

(l)(4) Testing protocol

(l)(4) *Testing protocol*.

(l)(4)(i) *Preconditioning*. The manufacturer must use an applicable cycle for preconditioning test engines prior to conducting each of the emission tests required by paragraph (l)(3) of this section. The manufacturer may perform a single additional preconditioning cycle, identical to the initial one, after a 20 minute hot soak but must demonstrate that such an additional cycle is necessary to stabilize the emissions control system. A practice of requiring a cold soak prior to conducting preconditioning cycles is not permitted.

(l)(4)(ii) *Test sequence*.

(l)(4)(ii)(A) The manufacturer must set individually each system or component on the test engine at the malfunction criteria limit prior to conducting the applicable preconditioning cycle(s). If a second preconditioning cycle is permitted in accordance with paragraph (l)(4)(i) of this section, the manufacturer may adjust the system or component to be tested before conducting the second preconditioning cycle. The manufacturer shall not replace, modify, or adjust the system or component after the last preconditioning cycle has been completed.

(l)(4)(ii)(B) After preconditioning, the test engine must be operated over the applicable cycle to allow for the initial detection of the tested system or component malfunction. This test cycle may be omitted from the testing protocol if it is unnecessary. If required by the monitoring strategy being tested, a cold soak may be performed prior to conducting this test cycle.

(l)(4)(ii)(C) The test engine must then be operated over the applicable exhaust emissions test.

(l)(4)(iii) [Reserved.]

(l)(4)(iv) The manufacturer may request approval to use an alternative testing protocol for demonstration of MIL activation if the engine dynamometer emission test cycle does not allow all of a given monitor's enable conditions to be satisfied. The manufacturer may request the use of an alternative engine dynamometer test cycle or the use of chassis testing to demonstrate proper MIL activation. To do so, the manufacturer must demonstrate the technical necessity for using an

alternative test cycle and the degree to which the alternative test cycle demonstrates that in-use operation with the malfunctioning component will result in proper MIL activation.

(l)(5) Evaluation protocol

(l)(5) *Evaluation protocol*. Full OBD engine ratings, as defined by paragraph (o)(1) of this section, shall be evaluated according to the following protocol:

(l)(5)(i) For all tests conducted as required by paragraph (l) of this section, the MIL must activate before the end of the first engine start portion of the applicable test.

(l)(5)(ii) If the MIL activates prior to emissions exceeding the applicable malfunction criteria limits specified in paragraphs (g) through (i) of this section, no further demonstration is required. With respect to the misfire monitor demonstration test, if the manufacturer has elected to use the minimum misfire malfunction criteria of one percent as allowed in paragraph (h)(2)(ii)(B) of this section, no further demonstration is required provided the MIL activates with engine misfire occurring at the malfunction criteria limit.

(l)(5)(iii) If the MIL does not activate when the system or component is set at its malfunction criteria limit(s), the criteria limit(s) or the OBD system is not acceptable.

(l)(5)(iii)(A) Except for testing of the catalyst or DPF system, if the MIL first activates after emissions exceed the applicable malfunction criteria specified in paragraphs (g) through (i) of this section, the test engine shall be retested with the tested system or component adjusted so that the MIL will activate before emissions exceed the applicable malfunction criteria specified in paragraphs (g) through (i) of this section. If the component cannot be so adjusted because an alternative fuel or emission control strategy is used when a malfunction is detected (e.g., open loop fuel control used after an oxygen sensor malfunction is detected), the test engine shall be retested with the component adjusted to the worst acceptable limit (i.e., the applicable OBD monitor indicates that the component is performing at or slightly better than the malfunction criteria limit). When tested with the component so adjusted, the MIL must not activate during the test and the engine emissions must be below the applicable malfunction criteria specified in paragraphs (g) through (i) of this section.

(l)(5)(iii)(B) In testing the catalyst or DPF system, if the MIL first activates after emissions exceed the applicable emissions threshold(s) specified in paragraphs (g) and (h) of this section, the tested engine shall be retested with a less deteriorated catalyst or DPF system (i.e., more of the applicable engine out pollutants are converted or trapped). For the OBD system to be approved, testing shall be continued until the MIL activates with emissions below the applicable thresholds of paragraphs (g) and (h) of this section, or the MIL activates with emissions within a range no more than 20 percent below the applicable emissions thresholds and 10 percent or less above those emissions thresholds.

(l)(5)(iv) If an OBD system is determined to be unacceptable by the criteria of this paragraph (l)(5) of this section, the manufacturer may recalibrate and retest the system on the same test engine. In such a case, the manufacturer must confirm, by retesting, that all systems and components that were tested prior to the recalibration and are affected by it still function properly with the recalibrated OBD system.

(l)(6) Confirmatory testing

(l)(6) *Confirmatory testing*.

(l)(6)(i) The Administrator may perform confirmatory testing to verify the emission test data submitted by the manufacturer as required by this paragraph (l) of this section comply with its requirements and the malfunction criteria set forth in paragraphs (g) through (i) of this section. Such confirmatory testing is limited to the test engine required by paragraph (l)(2) of this section.

(l)(6)(ii) To conduct this confirmatory testing, the Administrator may install appropriately deteriorated or malfunctioning components (or simulate them) in an otherwise properly functioning test engine of an engine rating represented by the demonstration test engine in order to test any of the components or systems required to be tested by paragraph (l) of this section. The manufacturer shall make available, if requested, an engine and all test equipment (e.g., malfunction simulators, deteriorated components) necessary to duplicate the manufacturer's testing. Such a request from the Administrator shall occur within six months of reviewing and approving the demonstration test engine data submitted by the manufacturer for the specific engine rating.

(l)(7) Catalyst aging

(l)(7) *Catalyst aging*.

(l)(7)(i) *Diesel catalysts*. For purposes of determining the catalyst malfunction limits for the monitoring required by paragraphs (g)(5)(ii)(A), (g)(5)(ii)(B), and (g)(6)(ii)(A) of this section, where those catalysts are monitored individually, the manufacturer must use a catalyst deteriorated to the malfunction criteria using methods established by the manufacturer to represent real world catalyst deterioration under normal and malfunctioning engine operating conditions. For purposes of determining the catalyst malfunction limits for the monitoring required by paragraphs (g)(5)(ii)(A), (g)(5)(ii)(B), and (g)(6)(ii)(A) of this section, where those catalysts are monitored in combination with other catalysts, the manufacturer must submit their catalyst system aging and monitoring plan to the Administrator as part of their certification documentation package. The plan must include the description, emission control purpose, and location of each component, the monitoring strategy for each component and/or combination of components, and the method for determining the applicable malfunction criteria including the deterioration/aging process.

(l)(7)(ii) *Gasoline catalysts*. For the purposes of determining the catalyst system malfunction criteria in paragraph (h)(6)(ii) of this section, the manufacturer must use a catalyst system deteriorated to the malfunction criteria using methods established by the manufacturer to represent real world catalyst deterioration under normal and malfunctioning operating conditions. The malfunction criteria must be established by using a catalyst system with all monitored and unmonitored (downstream of the sensor utilized for catalyst monitoring) catalysts simultaneously deteriorated to the malfunction criteria except for those engines that use fuel shutoff to prevent over-fueling during engine misfire conditions. For such engines, the malfunction criteria must be established by using a catalyst system with all monitored catalysts simultaneously deteriorated to the malfunction criteria while unmonitored catalysts shall be deteriorated to the end of the engine's useful life.

(m) Certification documentation

(m) *Certification documentation requirements*.

(m)(1) When submitting an application for certification of an engine, the manufacturer must submit the following documentation. If any of the items listed here are standardized for all of the manufacturer's engines, the manufacturer may, for each model year, submit one set of documents covering the standardized items for all of its engines.

(m)(1)(i) For the required documentation that is not standardized across all engines, the manufacturer may be allowed to submit documentation for certification from one engine that is representative of other engines. All such engines shall be considered to be part of an OBD certification documentation group. To represent the OBD group, the chosen engine must be certified to the most stringent emissions standards and OBD monitoring requirements and cover all of the emissions control devices for the engines in the group and covered by the submitted documentation. Such OBD groups must be approved in advance of certification.

(m)(1)(ii) Upon approval, one or more of the documentation requirements of this paragraph (m) of this section may be waived or modified if the information required is redundant or unnecessarily burdensome to generate.

(m)(1)(iii) To the extent possible, the certification documentation must use SAE J1930 or J2403 terms, abbreviations, and acronyms.

(m)(2) Unless otherwise specified, the following information must be submitted as part of the certification application and prior to receiving a certificate.

(m)(2)(i) A description of the functional operation of the OBD system including a complete written description for each monitoring strategy that outlines every step in the decision-making process of the monitor. Algorithms, diagrams, samples of data, and/or other graphical representations of the monitoring strategy shall be included where necessary to adequately describe the information.

(m)(2)(ii) A table including the following information for each monitored component or system (either computer-sensed or computer-controlled) of the emissions control system:

(m)(2)(ii)(A) Corresponding diagnostic trouble code.

(m)(2)(ii)(B) Monitoring method or procedure for malfunction detection.

(m)(2)(ii)(C) Primary malfunction detection parameter and its type of output signal.

(m)(2)(ii)(D) Malfunction criteria limits used to evaluate output signal of primary parameter.

(m)(2)(ii)(E) Other monitored secondary parameters and conditions (in engineering units) necessary for malfunction detection.

(m)(2)(ii)(F) Monitoring time length and frequency of monitoring events.

(m)(2)(ii)(G) Criteria for storing a diagnostic trouble code.

(m)(2)(ii)(H) Criteria for activating a malfunction indicator light.

(m)(2)(ii)(I) Criteria used for determining out-of-range values and input component rationality checks.

(m)(2)(iii) Whenever possible, the table required by paragraph (m)(2)(ii) of this section shall use the following engineering units:

(m)(2)(iii)(A) Degrees Celsius for all temperature criteria.

(m)(2)(iii)(B) KiloPascals (KPa) for all pressure criteria related to manifold or atmospheric pressure.

(m)(2)(iii)(C) Grams (g) for all intake air mass criteria.

(m)(2)(iii)(D) Pascals (Pa) for all pressure criteria related to evaporative system vapor pressure.

(m)(2)(iii)(E) Miles per hour (mph) for all vehicle speed criteria.

(m)(2)(iii)(F) Relative percent (%) for all relative throttle position criteria (as defined in SAE J1979/J1939).

(m)(2)(iii)(G) Voltage (V) for all absolute throttle position criteria (as defined in SAE J1979/J1939).

(m)(2)(iii)(H) Per crankshaft revolution (/rev) for all changes per ignition event based criteria (e.g., g/rev instead of g/stroke or g/firing).

(m)(2)(iii)(I) Per second (/sec) for all changes per time based criteria (e.g., g/sec).

(m)(2)(iii)(J) Percent of nominal tank volume (%) for all fuel tank level criteria.

(m)(2)(iv) A logic flowchart describing the step-by-step evaluation of the enable criteria and malfunction criteria for each monitored emission related component or system.

(m)(2)(v) Emissions test data, a description of the testing sequence (e.g., the number and types of preconditioning cycles), approximate time (in seconds) of MIL activation during the test, diagnostic trouble code(s) and freeze frame information stored at the time of detection, corresponding test results (e.g. SAE J1979 Mode/Service $06, SAE J1939 Diagnostic Message 8 (DM8)) stored during the test, and a description of the modified or deteriorated components used for malfunction simulation with respect to the demonstration tests specified in paragraph (l) of this section. The freeze frame data are not required for engines subject to paragraph (o)(2) of this section.

(m)(2)(vi) For gasoline engines, data supporting the misfire monitor, including:

(m)(2)(vi)(A) The established percentage of misfire that can be tolerated without damaging the catalyst over the full range of engine speed and load conditions.

(m)(2)(vi)(B) Data demonstrating the probability of detection of misfire events by the misfire monitoring system over the full engine speed and load operating range for the following misfire patterns: random cylinders misfiring at the malfunction criteria established in paragraph (h)(2)(ii)(B) of this section, one cylinder continuously misfiring, and paired cylinders continuously misfiring.

(m)(2)(vi)(C) Data identifying all disablement of misfire monitoring that occurs during the FTP. For every disablement that occurs during the cycles, the data shall identify: when the disablement occurred relative to the driver's trace, the number of engine revolutions during which each disablement was present, and which disable condition documented in the certification application caused the disablement.

(m)(2)(vi)(D) Manufacturers are not required to use the durability demonstration engine to collect the misfire data required by paragraph (m)(2)(vi) of this section.

(m)(2)(vii) Data supporting the limit for the time between engine starting and attaining the designated heating temperature for after-start heated catalyst systems.

(m)(2)(viii) Data supporting the criteria used to detect a malfunction of the fuel system, EGR system, boost pressure control system, catalyst, NOx adsorber, DPF, cold start emission reduction strategy, secondary air, evaporative system, VVT system, exhaust gas sensors, and other emission controls that causes emissions to exceed the applicable malfunction criteria

specified in paragraphs (g) through (i) of this section. For diesel engine monitors required by paragraphs (g) and (i) of this section that are required to indicate a malfunction before emissions exceed an emission threshold based on any applicable standard (e.g., 2.5 times any of the applicable standards), the test cycle and standard determined by the manufacturer to be the most stringent for each applicable monitor in accordance with paragraph (f)(1) of this section.

(m)(2)(ix) A list of all electronic powertrain input and output signals (including those not monitored by the OBD system) that identifies which signals are monitored by the OBD system. For input and output signals that are monitored as comprehensive components, the listing shall also identify the specific diagnostic trouble code for each malfunction criteria (e.g., out-of-range low, out-of-range high, open circuit, rationality low, rationality high).

(m)(2)(x) A written description of all parameters and conditions necessary to begin closed-loop/feedback control of emission control systems (e.g., fuel system, boost pressure, EGR flow, SCR reductant delivery, DPF regeneration, fuel system pressure).

(m)(2)(xi) A written identification of the communication protocol utilized by each engine for communication with a scan tool.

(m)(2)(xii) [Reserved.]

(m)(2)(xiii) A written description of the method used by the manufacturer to meet the requirements of paragraph (i)(2) of this section (crankcase ventilation system monitoring) including diagrams or pictures of valve and/or hose connections.

(m)(2)(xiv) Build specifications provided to engine purchasers or chassis manufacturers detailing all specifications or limitations imposed on the engine purchaser relevant to OBD requirements or emissions compliance (e.g., cooling system heat rejection rates). A description of the method or copies of agreements used to ensure engine purchasers or chassis manufacturers will comply with the OBD and emissions relevant build specifications (e.g., signed agreements, required audit/evaluation procedures).

(m)(2)(xv) Any other information determined by the Administrator to be necessary to demonstrate compliance with the requirements of this section.

(n) Deficiencies

(n) *Deficiencies*.

(n)(1) Upon application by the manufacturer, the Administrator may accept an OBD system as compliant even though specific requirements are not fully met. Such compliances without meeting specific requirements, or deficiencies, will be granted only if compliance is infeasible or unreasonable considering such factors as, but not limited to: technical feasibility of the given monitor and lead time and production cycles including phase-in or phase-out of engines or vehicle designs and programmed upgrades of computers. Unmet requirements shall not be carried over from the previous model year except where unreasonable hardware or software modifications are necessary to correct the deficiency, and the manufacturer has demonstrated an acceptable level of effort toward compliance as determined by the Administrator. Furthermore, EPA will not accept any deficiency requests that include the complete lack of a major diagnostic monitor (“major” diagnostic monitors being those for exhaust aftertreatment devices, oxygen sensor, air-fuel ratio sensor, NOx sensor, engine misfire, evaporative leaks, and diesel EGR, if equipped), with the possible exception of the special provisions for alternative fueled engines. For alternative fueled heavy-duty engines (e.g. natural gas, liquefied petroleum gas, methanol, ethanol), manufacturers may request the Administrator to waive specific monitoring requirements of this section for which monitoring may not be reliable with respect to the use of the alternative fuel. At a minimum, alternative fuel engines must be equipped with an OBD system meeting OBD requirements to the extent feasible as approved by the Administrator.

(n)(2) In the event the manufacturer seeks to carry-over a deficiency from a past model year to the current model year, the manufacturer must re-apply for approval to do so. In considering the request to carry-over a deficiency, the Administrator shall consider the manufacturer’s progress towards correcting the deficiency. The Administrator may not allow manufacturers to carry over monitoring system deficiencies for more than two model years unless it can be demonstrated that substantial engine hardware modifications and additional lead time beyond two years are necessary to correct the deficiency.

(n)(3) A deficiency shall not be granted retroactively (i.e., after the engine has been certified).

(o) Implementation schedule

(o) *Implementation schedule*. Except as provided for in paragraphs (o)(4) and (o)(5) of this section, the requirements of this section must be met according to the following provisions:

(o)(1) *Full OBD*. The manufacturer must implement an OBD system meeting the requirements of this section on one engine rating within one engine family of the manufacturer's product line. This "full OBD" rating will be known as the "OBD parent" rating. The OBD parent rating must be chosen as the rating having the highest weighted projected US sales within the engine family having the highest weighted projected US sales, with US sales being weighted by the useful life of the engine rating.

(o)(2) *Extrapolated OBD*. For all other engine ratings within the engine family from which the OBD parent rating has been selected, the manufacturer must implement an OBD system meeting the requirements of this section except that the OBD system is not required to detect a malfunction prior to exceeding the emission thresholds shown in Table 1 of paragraph (g) of this section and Table 2 of paragraph (h) of this section. These extrapolated OBD engines will be know as the "OBD child" ratings. On these OBD child ratings, rather than detecting a malfunction prior to exceeding the emission thresholds, the manufacturer must submit a plan for Administrator review and approval that details the engineering evaluation the manufacturer will use to establish the malfunction criteria for the OBD child ratings. The plan must demonstrate both the use of good engineering judgment in establishing the malfunction criteria, and robust detection of malfunctions, including consideration of differences of base engine, calibration, emission control components, and emission control strategies.

(o)(3) Engine families other than those from which the parent and child ratings have been selected, are not subject to the requirements of this section.

(o)(4) Small volume manufacturers, as defined in §86.094-14(b)(1) and (2), are exempt from the requirements of §86.010-18.

(o)(5) Engines certified as alternative fueled engines are exempt from the requirements of §86.010-18.

(p) In-use compliance standards

(p) *In-use compliance standards*. For monitors required to indicate a malfunction before emissions exceed a certain emission threshold (e.g., 2.5 times any of the applicable standards):

(p)(1) On the full OBD rating (i.e., the parent rating) as defined in paragraph (o)(1) of this section, separate in-use emissions thresholds shall apply. These thresholds are determined by doubling the applicable thresholds as shown in Table 1 of paragraph (g) and Table 2 of paragraph (h) of this section. The resultant thresholds apply only in-use and do not apply for certification or selective enforcement auditing.

(p)(2) The extrapolated OBD ratings (i.e., the child ratings) as defined in paragraph (o)(2) of this section shall not be evaluated against emissions levels for purposes of OBD compliance in-use.

(p)(3) Only the test cycle and standard determined and identified by the manufacturer at the time of certification in accordance with paragraph (f) of this section as the most stringent shall be used for the purpose of determining OBD system noncompliance in-use.

(p)(4) An OBD system shall not be considered noncompliant solely due to a failure or deterioration mode of a monitored component or system that could not have been reasonably foreseen to occur by the manufacturer.

§ 86.010-30 Certification.

Section 86.010–30 includes text that specifies requirements that differ from §§86.094–30, 86.095–30, 86.096–30, 86.098–30, 86.001–30, 86.004–30 or 86.007–30. Where a paragraph in §86.094–30, §86.095–30, §86.096–30, §86.098–30, §86.001–30, §86.004-30 or §86.007-30 is identical and applicable to §86.010–30, this may be indicated by specifying the corresponding paragraph and the statement "[Reserved]. For guidance see §86.094–30." or "[Reserved]. For

guidance see §86.095–30.” or “[Reserved]. For guidance see §86.096–30.” or “[Reserved]. For guidance see §86.098–30.” or “[Reserved]. For guidance see §86.001–30.” or “[Reserved]. For guidance see §86.004-30.” or “[Reserved]. For guidance see §86.007-30.”

(a) thru (e)

(a)(1) and (a)(2) [Reserved]. For guidance see §86.094–30.
(a)(3)(i) through (a)(4)(ii) [Reserved]. For guidance see §86.004-30.
(a)(4)(iii) introductory text through (a)(4)(iii)(C) [Reserved]. For guidance see §86.094–30.
(a)(4)(iv) introductory text [Reserved]. For guidance see §86.095–30.
(a)(4)(iv)(A)–(a)(9) [Reserved]. For guidance see §86.094–30.
(a)(10) and (a)(11) [Reserved]. For guidance see §86.004-30.
(a)(12) [Reserved]. For guidance see §86.094–30.
(a)(13) [Reserved]. For guidance see §86.095–30.
(a)(14) [Reserved]. For guidance see §86.094–30.
(a)(15)–(18) [Reserved]. For guidance see §86.096–30.
(a)(19) [Reserved]. For guidance see §86.098–30.
(a)(20) [Reserved]. For guidance see §86.001–30.
(a)(21) [Reserved]. For guidance see §86.004-30.
(b)(1) introductory text through (b)(1)(ii)(A) [Reserved]. For guidance see §86.094–30.
(b)(1)(ii)(B) [Reserved]. For guidance see §86.004-30.
(b)(1)(ii)(C) [Reserved]. For guidance see §86.094–30.
(b)(1)(ii)(D) [Reserved]. For guidance see §86.004-30.
(b)(1)(iii) and (b)(1)(iv) [Reserved]. For guidance see §86.094–30.
(b)(2) [Reserved]. For guidance see §86.098–30.
(b)(3)–(b)(4)(i) [Reserved]. For guidance see §86.094–30.
(b)(4)(ii) introductory text [Reserved]. For guidance see §86.098–30.
(b)(4)(ii)(A) [Reserved]. For guidance see §86.094–30.
(b)(4)(ii)(B)–(b)(4)(iv) [Reserved]. For guidance see §86.098–30.
(b)(5)–(e) [Reserved]. For guidance see §86.094–30.

(f) OBD certification

(f) For engine families required to have an OBD system and meant for applications less than or equal to 14,000 pounds GVWR, certification will not be granted if, for any test vehicle approved by the Administrator in consultation with the manufacturer, the malfunction indicator light does not activate under any of the following circumstances, unless the manufacturer can demonstrate that any identified OBD problems discovered during the Administrator’s evaluation will be corrected on production vehicles.

(f)(1)(i) *Otto-cycle*. [Reserved]. For guidance see §86.004-30.

(f)(1)(ii) *Diesel*.

(f)(1)(ii)(A) If monitored for emissions performance—a reduction catalyst is replaced with a deteriorated or defective catalyst, or an electronic simulation of such, resulting in exhaust NOx emissions exceeding the applicable NOx FEL+0.3 g/bhp-hr. Also if monitored for emissions performance—an oxidation catalyst is replaced with a deteriorated or defective catalyst, or an electronic simulation of such, resulting in exhaust NMHC emissions exceeding 2.5 times the applicable NMHC standard.

(f)(1)(ii)(B) If monitored for performance—a particulate trap is replaced with a deteriorated or defective trap, or an electronic simulation of such, resulting in either exhaust PM emissions exceeding the applicable FEL+0.04 g/bhp-hr or 0.05 g/bhp-hr PM, whichever is higher; or, exhaust NMHC emissions exceeding 2.5 times the applicable NMHC standard. Also, if monitored for performance—a particulate trap is replaced with a catastrophically failed trap or a simulation of such.

(f)(2) [Reserved]. For guidance see §86.004-30.

(f)(3)(i) *Oxygen sensors and air-fuel ratio sensors downstream of aftertreatment devices.*

(f)(3)(i)(A) [Reserved]. For guidance see §86.007-30.

(f)(3)(i)(B) *Diesel*. If so equipped, any oxygen sensor or air-fuel ratio sensor located downstream of aftertreatment devices is replaced with a deteriorated or defective sensor, or an electronic simulation of such, resulting in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.04 g/bhp-hr or 0.05 g/bhp-hr PM, whichever is higher; or, the applicable NOx FEL+0.3 g/bhp-hr; or, 2.5 times the applicable NMHC standard.

(f)(3)(ii) *Oxygen sensors and air-fuel ratio sensors upstream of aftertreatment devices*.

(f)(3)(ii)(A) [Reserved]. For guidance see §86.007-30.

(f)(3)(ii)(B) *Diesel*. If so equipped, any oxygen sensor or air-fuel ratio sensor located upstream of aftertreatment devices is replaced with a deteriorated or defective sensor, or an electronic simulation of such, resulting in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.02 g/bhp-hr or 0.03 g/bhp-hr PM, whichever is higher; or, the applicable NOx FEL+0.3 g/bhp-hr; or, 2.5 times the applicable NMHC standard; or, 2.5 times the applicable CO standard.

(f)(3)(iii) *NOx sensors*.

(f)(3)(iii)(A) [Reserved]. For guidance see §86.007-30.

(f)(3)(iii)(B) *Diesel*. If so equipped, any NOx sensor is replaced with a deteriorated or defective sensor, or an electronic simulation of such, resulting in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.04 g/bhp-hr or 0.05 g/bhp-hr PM, whichever is higher; or, the applicable NOx FEL+0.3 g/bhp-hr.

(f)(4) [Reserved]. For guidance see §86.004-30.

(f)(5)(i) [Reserved]. For guidance see §86.007-30.

(f)(5)(ii) *Diesel*. A malfunction condition is induced in any emission-related engine system or component, including but not necessarily limited to, the exhaust gas recirculation (EGR) system, if equipped, and the fuel control system, singularly resulting in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.02 g/bhp-hr or 0.03 g/bhp-hr PM, whichever is higher; or, the applicable NOx FEL+0.3 g/bhp-hr; or, 2.5 times the applicable NMHC standard; or, 2.5 times the applicable CO standard.

(f)(6) [Reserved]. For guidance see §86.004-30.

§ 86.010-38 Maintenance instructions.

This Section 86.010-38 includes text that specifies requirements that differ from those specified in §86.007–38. Where a paragraph in §86.096-38, or §86.004-38, or §86.007-38 is identical and applicable to §86.010–38, this may be indicated by specifying the corresponding paragraph and the statement "[Reserved]. For guidance see §86.096-38, "[Reserved]. For guidance see or §86.004-38, or "[Reserved]. For guidance see §86.007-38.".

(a) thru (i)

(a)–(f) [Reserved]. For guidance see §86.004–38.

(g) [Reserved]. For guidance see §86.096–38. For incorporation by reference see §§86.1 and 86.096–38.

(h) [Reserved]. For guidance see §86.004–38.

(i) [Reserved]. For guidance see §86.007-38.

(j) Service info for >14K applications

(j) Emission control diagnostic service information for heavy-duty engines used in vehicles over 14,000 pounds gross vehicle weight (GVW)

(j)(1) Manufacturers of heavy-duty engines used in applications weighing more than 14,000 pounds gross vehicle weight (GVW) that are subject to the applicable OBD requirements of this subpart A are subject to the provisions of this paragraph (j) beginning in the 2010 model year.

The provisions of this paragraph (j) apply only to those heavy-duty engines subject to the applicable OBD requirements.

(j)(2) Upon Administrator approval, manufacturers may alternatively comply with all service information and tool provisions found in §86.096-38 that are applicable to 1996 and subsequent vehicles weighing less than 14,000 pounds gross vehicle weigh (GVW).

(j)(3) General Requirements

(j)(3)(i) Manufacturers shall furnish or cause to be furnished to any person engaged in the repairing or servicing of heavy-duty engines, or the Administrator upon request, any and all information needed to make use of the on-board diagnostic system and such other information, including instructions for making emission-related diagnosis and repairs, including but not limited to service manuals, technical service bulletins, recall service information, bi-directional control information, and training information, unless such information is protected by section 208(c) as a trade secret. No such information may be withheld under section 208(c) of the Act if that information is provided (directly or indirectly) by the manufacturer to franchised dealers or other persons engaged in the repair, diagnosing, or servicing of heavy-duty engines.

(j)(3)(ii) *Definitions*. The following definitions apply for this paragraph (j):

(j)(3)(ii)(A) Aftermarket service provider means any individual or business engaged in the diagnosis, service, and repair of a heavy-duty engine, who is not directly affiliated with a manufacturer or manufacturer franchised dealership.

(j)(3)(ii)(B) Bi-directional control means the capability of a diagnostic tool to send messages on the data bus that temporarily overrides the module's control over a sensor or actuator and gives control to the diagnostic tool operator. Bi-directional controls do not create permanent changes to engine or component calibrations.

(j)(3)(ii)(C) Data stream information means information (i.e., messages and parameters) originated within the engine by a module or intelligent sensors (i.e., a sensor that contains and is controlled by its own module) and transmitted between a network of modules and/or intelligent sensors connected in parallel with either one or more communication wires. The information is broadcast over the communication wires for use by the OBD system to gather information on emissions-related components or systems and from other engine modules that may impact emissions. For the purposes of this section, data stream information does not include engine calibration related information, or any data stream information from systems or modules that do not impact emissions.

(j)(3)(ii)(D) Emissions-related information means any information related to the diagnosis, service, and repair of emissions-related components. Emissions-related information includes, but is not limited to, information regarding any system, component or part of an engine that controls emissions and any system, component and/or part associated with the engine, including, but not limited to: the engine, the fuel system and ignition system; information for any system, component or part that is likely to impact emissions, and any other information specified by the Administrator to be relevant to the diagnosis and repair of an emissions-related problem; any other information specified by the Administrator to be relevant for the diagnosis and repair of an emissions-related failure found through an evaluation of vehicles in-use and after such finding has been communicated to the affected manufacturer(s).

(j)(3)(ii)(E) Emissions-related training information means any information related training or instruction for the purpose of the diagnosis, service, and repair of emissions-related components.

(j)(3)(ii)(F) Enhanced service and repair information means information which is specific for an original equipment manufacturer's brand of tools and equipment. This includes computer or anti-theft system initialization information necessary for the completion of any emissions-related repair on engines that employ integral security systems.

(j)(3)(ii)(G) Equipment and Tool Company means a registered equipment or software company either public or private that is engaged in, or plans to engage in, the manufacture of scan tool reprogramming equipment or software.

(j)(3)(ii)(H) Generic service and repair information means information which is not specific for an original equipment manufacturer’s brand of tools and equipment.

(j)(3)(ii)(I) Indirect information means any information that is not specifically contained in the service literature, but is contained in items such as tools or equipment provided to franchised dealers (or others). This includes computer or anti-theft system initialization information

necessary for the completion of any emissions-related repair on engines that employ integral security systems.

(j)(3)(ii)(J) Intermediary means any individual or entity, other than an original equipment manufacturer, which provides service or equipment to aftermarket service providers.

(j)(3)(ii)(K) Manufacturer franchised dealership means any service provider with which a manufacturer has a direct business relationship.

(j)(3)(ii)(L) Third party information provider means any individual or entity, other than an original equipment manufacturer, who consolidates manufacturer service information and makes this information available to aftermarket service providers.

(j)(3)(ii)(M) Third party training provider means any individual or entity, other than an original equipment manufacturer who develops and/or delivers instructional and educational material for training courses.

(j)(4) *Information dissemination*. By July 1, 2010 each manufacturer shall provide or cause to be provided to the persons specified in paragraph (j)(3)(i) of this section and to any other interested parties a manufacturer-specific World Wide Web site containing the information specified in paragraph (j)(3)(i) of this section for 2010 and later model year engines which have been certified to the OBD requirements specified in §86.010-18 and are offered for sale; this requirement does not apply to indirect information, including the information specified in paragraphs (j)(13) through (j)(17) of this section. Upon request and approval of the Administrator, manufacturers who can demonstrate significant hardship in complying with this provision within four months after the effective date may request an additional six months lead time to meet this requirement. Each manufacturer Web site shall:

(j)(4)(i) Provide access in full-text to all of the information specified in paragraph (j)(5) of this section.

(j)(4)(ii) Be updated at the same time as manufacturer franchised dealership World Wide Web sites.

(j)(4)(iii) Provide users with a description of the minimum computer hardware and software needed by the user to access that manufacturer's information (e.g., computer processor speed and operating system software). This description shall appear when users first log-on to the home page of the manufacturer's Web site.

(j)(4)(iv) Provide Short-Term (24 to 72 hours), Mid-Term (30 day period), and Long-Term (365 day period) Web site subscription options to any person specified in paragraph (j)(2)(i) of this section whereby the user will be able to access the site, search for the information, and purchase, view and print the information at a fair and reasonable cost as specified in paragraph (j)(7) of this section for each of the options. In addition, for each of the tiers, manufacturers are required to make their entire site accessible for the respective period of time and price. In other words, a manufacturer may not limit any or all of the tiers to just one make or one model.

(j)(4)(v) Allow the user to search the manufacturer Web site by various topics including but not limited to model, model year, key words or phrases, etc., while allowing ready identification of the latest calibration. Manufacturers who do not use model year to classify their engines in their service information may use an alternate delineation such as body series. Any manufacturer utilizing this flexibility shall create a cross-reference to the corresponding model year and provide this cross-reference on the manufacturer Web site home page.

(j)(4)(vi) Provide accessibility using common, readily available software and shall not require the use of software, hardware, viewers, or browsers that are not readily available to the general public. Manufacturers shall also provide hyperlinks to any plug-ins, viewers or browsers (e.g. Adobe Acrobat or Netscape) needed to access the manufacturer Web site.

(j)(4)(vii) Allow simple hyper-linking to the manufacturer Web site from Government Web sites and automotive-related Web sites.

(j)(4)(viii) Posses sufficient server capacity to allow ready access by all users and has sufficient capacity to assure that all users may obtain needed information without undue delay.

(j)(4)(ix) Correct or delete broken Web links on a weekly basis.

(j)(4)(x) Allow for Web site navigation that does not require a user to return to the manufacturer home page or a search engine in order to access a different portion of the site.

(j)(4)(xi) Allow users to print out any and all of the materials required to be made available on the manufacturers Web site, including the ability to print it at the user’s location.

(j)(5) *Small volume provisions for information dissemination*.

(j)(5)(i) Manufacturers with total annual sales of less than 5,000 engines shall have until July 1, 2011 to launch their individual Web sites as required by paragraph (j)(4) of this section.

(j)(5)(ii) Manufacturers with total annual sales of less than 1,000 engines may, in lieu of meeting the requirement of paragraph (j)(4) of this section, request the Administrator to approve an alternative method by which the required emissions-related information can be obtained by the persons specified in paragraph (j)(3)(i) of this section.

(j)(6) *Required information*. All information relevant to the diagnosis and completion of emissions-related repairs shall be posted on manufacturer Web sites. This excludes indirect information specified in paragraphs (j)(7) and (j)(13) through (j)(17) of this section. To the extent that this information does not already exist in some form for their manufacturer franchised dealerships, manufacturers are required to develop and make available the information required by this section to both their manufacturer franchised dealerships and the aftermarket. The required information includes, but is not limited to:

(j)(6)(i) Manuals, including subsystem and component manuals developed by a manufacturer's third party supplier that are made available to manufacturer franchised dealerships, technical service bulletins (TSBs), recall service information, diagrams, charts, and training materials. Manuals and other such service information from third party suppliers are not required to be made available in full-text on manufacturer Web sites as described in paragraph (j)(3) of this section. Rather, manufacturers must make available on the manufacturer Web site as required by paragraph (j)(3) of this section an index of the relevant information and instructions on how to order such information. In the alternate, a manufacturer can create a link from its Web site to the Web site(s) of the third party supplier.

(j)(6)(ii) OBD system information which includes, but is not limited to, the following:

(j)(6)(ii)(A) a general description of the operation of each monitor, including a description of the parameter that is being monitored;

(j)(6)(ii)(B) a listing of all typical OBD diagnostic trouble codes associated with each monitor;

(j)(6)(ii)(C) a description of the typical enabling conditions (either generic or monitor-specific) for each monitor (if equipped) to execute during engine operation, including, but not limited to, minimum and maximum intake air and engine coolant temperature, speed range, and time after engine startup. In addition, manufacturers shall list all monitor-specific OBD drive cycle information for all major OBD monitors as equipped including, but not limited to, catalyst, catalyst heater, oxygen sensor, oxygen sensor heater, evaporative system, exhaust gas re-circulation (EGR), secondary air, and air conditioning system. Additionally, for diesel engines which also perform misfire, fuel system and comprehensive component monitoring under specific driving conditions (i.e., non-continuous monitoring; as opposed to spark ignition engines that monitor these systems under all conditions or continuous monitoring), the manufacturer shall make available monitor-specific drive cycles for these monitors. Any manufacturer who develops generic drive cycles, either in addition to, or instead of, monitor-specific drive cycles shall also make these available in full-text on manufacturer Web sites;

(j)(6)(ii)(D) a listing of each monitor sequence, execution frequency and typical duration;

(j)(6)(ii)(E) a listing of typical malfunction thresholds for each monitor;

(j)(6)(ii)(F) for OBD parameters for specific engines that deviate from the typical parameters, the OBD description shall indicate the deviation and provide a separate listing of the typical values for those engines;

(j)(6)(ii)(G) identification and scaling information necessary to interpret and understand data available through Diagnostic Message 8 pursuant to SAE Recommended Practice J1939-73, Application Layer – Diagnostics, revised June 2001 or through Service/Mode $06 pursuant to SAE Recommended Practice J1979, E/E Diagnostic Test Modes – Equivalent to ISO/DIS 15031-5: April 30, 2002. These documents are Incorporated by Reference in §86.1.

(j)(6)(ii)(H) Algorithms, look-up tables, or any values associated with look-up tables are not required to be made available.

(j)(6)(iii) Any information regarding any system, component, or part of a engine monitored by the OBD system that could in a failure mode cause the OBD system to illuminate the malfunction indicator light (MIL);

(j)(6)(iv) Manufacturer-specific emissions-related diagnostic trouble codes (DTCs) and any related service bulletins, trouble shooting guides, and/or repair procedures associated with these manufacturer-specific DTCs; and

(j)(6)(v) Information regarding how to obtain the information needed to perform reinitialization of any computer or anti-theft system following an emissions-related repair.

(j)(7) *Anti-theft System Initialization Information*. Computer or anti-theft system initialization information and/or related tools necessary for the proper installation of on-board computers or necessary for the completion of any emissions-related repair on engines that employ integral security systems or the repair or replacement of any other emission-related part shall be made available at a fair and reasonable cost to the persons specified in paragraph (j)(3)(i) of this section.

(j)(7)(i) Except as provided under paragraph (j)(7)(ii) of this section, manufacturers must make this information available to persons specified in paragraph (j)(3)(i) of this section, such that such persons will not need any special tools or manufacturer-specific scan tools to perform the initialization. Manufacturers may make such information available through, for example, generic aftermarket tools, a pass-through device, or inexpensive manufacturer specific cables.

(j)(7)(ii) A manufacturer may request Administrator approval for an alternative means to re-initialize engines for some or all model years through the 2013 model year by 90 days following the effective date of the final rule. The Administrator shall approve the request only after the following conditions have been met:

(j)(7)(ii)(A) The manufacturer must demonstrate that the availability of such information to aftermarket service providers would significantly increase the risk of theft.

(j)(7)(ii)(B) The manufacturer must make available a reasonable alternative means to install or repair computers, or to otherwise repair or replace an emission-related part.

(j)(7)(ii)(C) Any alternative means proposed by a manufacturer cannot require aftermarket technicians to use a manufacturer franchised dealership to obtain information or special tools to re-initialize the anti-theft system. All information must come directly from the manufacturer or a single manufacturer-specified designee.

(j)(7)(ii)(D) Any alternative means proposed by a manufacturer must be available to aftermarket technicians at a fair and reasonable price.

(j)(7)(ii)(E) Any alternative must be available to aftermarket technicians within twenty-four hours of the initial request.

(j)(7)(ii)(F) Any alternative must not require the purchase of a special tool or tools, including manufacturer-specific tools, to complete this repair. Alternatives may include lease of such tools, but only for appropriately minimal cost.

(j)(7)(ii)(G) In lieu of leasing their manufacturer-specific tool to meet this requirement, a manufacturer may also choose to release the necessary information to equipment and tool manufacturers for incorporation into aftermarket scan tools. Any manufacturer choosing this option must release the information to equipment and tool manufacturers within 60 days of Administrator approval.

(j)(8) *Cost of required information*.

(j)(8)(i) All information required to be made available by this section, shall be made available at a fair and reasonable price. In determining whether a price is fair and reasonable, consideration may be given to relevant factors, including, but not limited to, the following:

(j)(8)(i)(A) The net cost to the manufacturer franchised dealerships for similar information obtained from manufacturers, less any discounts, rebates, or other incentive programs;

(j)(8)(i)(B) The cost to the manufacturer for preparing and distributing the information, excluding any research and development costs incurred in designing and implementing, upgrading or altering the onboard computer and its software or any other engine part or component. Amortized capital costs for the preparation and distribution of the information may be included;

(j)(8)(i)(C) The price charged by other manufacturers for similar information;

(j)(8)(i)(D) The price charged by manufacturers for similar information prior to the launch of manufacturer Web sites;

(j)(8)(i)(E) The ability of the average aftermarket technician or shop to afford the information;

(j)(8)(i)(F) The means by which the information is distributed;

(j)(8)(i)(G) The extent to which the information is used, which includes the number of users, and frequency, duration, and volume of use; and

(j)(8)(i)(H) Inflation.

(j)(8)(ii) Manufacturers must submit to EPA a request for approval of their pricing structure for their Web sites and amounts to be charged for the information required to be made available under paragraphs (j)(4) and (j)(6) of this section at least 180 days in advance of the launch of the web site. Subsequent to the approval of the manufacturer Web site pricing structure, manufacturers shall notify EPA upon the increase in price of any one or all of the subscription options of 20 percent or more above the previously approved price, taking inflation into account.

(j)(8)(ii)(A) The manufacturer shall submit a request to EPA that sets forth a detailed description of the pricing structure and amounts, and support for the position that the pricing structure and amounts are fair and reasonable by addressing, at a minimum, each of the factors specified in paragraph (j)(8)(i) of this section.

(j)(8)(ii)(B) EPA will act upon on the request within180 days following receipt of a complete request or following receipt of any additional information requested by EPA.

(j)(8)(ii)(C) EPA may decide not to approve, or to withdraw approval for a manufacturer's pricing structure and amounts based on a conclusion that this pricing structure and/or amounts are not, or are no longer, fair and reasonable, by sending written notice to the manufacturer explaining the basis for this decision.

(j)(8)(ii)(D) In the case of a decision by EPA not to approve or to withdraw approval, the manufacturer shall within three months following notice of this decision, obtain EPA approval for a revised pricing structure and amounts by following the approval process described in this paragraph.

(j)(9) *Unavailable information*. Any information which is not provided at a fair and reasonable price shall be considered unavailable, in violation of these regulations and section 202(m)(5) of the Clean Air Act.

(j)(10) *Third party information providers*. By January 1, 2011 manufacturers shall, for model year 2010 and later engines, make available to third-party information providers as defined in paragraph (j)(3)(ii) of this section with whom they engage in licensing or business arrangements;

(j)(10)(i) the required emissions-related information as specified in paragraph (j)(6) of this section either:

(j)(10)(i)(A) directly in electronic format such as diskette or CD-ROM using non-proprietary software, in English; or

(j)(10)(i)(B) indirectly via a Web site other than that required by paragraph (j)(4) of this section;

(j)(10)(ii) for any manufacturer who utilizes an automated process in their manufacturer-specific scan tool for diagnostic fault trees, the data schema, detail specifications, including category types/codes and engine codes, and data format/content structure of the diagnostic trouble trees.

(j)(10)(iii) Manufacturers can satisfy the requirement of paragraph (j)(10)(ii) of this section by making available diagnostic trouble trees on their manufacturer Web sites in full-text.

(j)(10)(iv) Manufacturers are not responsible for the accuracy of the information distributed by third parties. However, where manufacturers charge information intermediaries for information, whether through licensing agreements or other arrangements, manufacturers are responsible for inaccuracies contained in the information they provide to third party information providers.

(j)(11) *Required emissions-related training information*. By January 1, 2011, for emissions-related training information, manufacturers shall:

(j)(11)(i) Video tape or otherwise duplicate and make available for sale on manufacturer Web sites within 30 days after transmission any emissions-related training courses provided to manufacturer franchised dealerships via the Internet or satellite transmission;

(j)(11)(ii) Provide on the manufacturer Web site an index of all emissions-related training information available for purchase by aftermarket service providers for 2010 and newer engines. The required information must be made available for purchase within 3 months of model introduction and then must be made available at the same time it is made available to manufacturer franchised dealerships, whichever is earlier. The index shall describe the title of the course or instructional session, the cost of the video tape or duplicate, and information on how to

order the item(s) from the manufacturer Web site. All of the items available must be shipped within 24 hours of the order being placed and are to made available at a fair and reasonable price as described in paragraph (j)(8) of this section. Manufacturers unable to meet the 24 hour shipping requirement under circumstances where orders exceed supply and additional time is needed by the distributor to reproduce the item being ordered, may exceed the 24 hour shipping requirement, but in no instance can take longer than 14 days to ship the item.

(j)(11)(iii) Provide access to third party training providers as defined in paragraph (j)(3)(ii) of this section all emission-related training courses transmitted via satellite or Internet offered to their manufacturer franchised dealerships. Manufacturers may not charge unreasonable up-front fees to third party training providers for this access, but may require a royalty, percentage, or other arranged fee based on per-use enrollment/subscription basis. Manufacturers may take reasonable steps to protect any copyrighted information and are not required to provide this information to parties that do not agree to such steps.

(j)(12) *Timeliness and maintenance of information dissemination*.

(j)(12)(i) Subsequent to the initial launch of the manufacturer's Web site, manufacturers must make the information required under paragraph (j)(6) of this section available on their Web site within six months of model introduction, or at the same time it is made available to manufacturer franchised dealerships. After this six month period, the information must be available and updated on the manufacturer Web site at the same time that the updated information is made available to manufacturer franchised dealerships, except as otherwise specified in this section.

(j)(12)(ii) *Archived information*. Manufacturers must maintain the required information on their Web sites in full-text as defined in paragraph (j)(6) of this section for a minimum of 15 years after model introduction. Subsequent to this fifteen year period, manufacturers may archive the information in the manufacturer's format of choice and provide an index of the archived information on the manufacturer Web site and how it can be obtained by interested parties. Manufacturers shall index their available information with a title that adequately describes the contents of the document to which it refers. Manufacturers may allow for the ordering of information directly from their Web site, or from a Web site hyperlinked to the manufacturer Web site. In the alternate, manufacturers shall list a phone number and address where aftermarket service providers can call or write to obtain the desired information. Manufacturers must also provide the price of each item listed, as well as the price of items ordered on a subscription basis. To the extent that any additional information is added or changed for these model years, manufacturers shall update the index as appropriate. Manufacturers will be responsible for ensuring that their information distributors do so within one regular business day of receiving the order. Items that are less than 20 pages (e.g. technical service bulletins) shall be faxed to the requestor and distributors are required to deliver the information overnight if requested and paid for by the ordering party. Archived information must be made available on demand and at a fair and reasonable price.

(j)(13) *Recalibration Information*.

(j)(13)(i) Manufacturers shall make available to the persons specified in paragraph (j)(3)(i) of this section all emissions-related recalibration or reprogramming events (including driveability reprogramming events that may affect emissions) in the format of their choice at the same time they are made available to manufacturer franchised dealerships. This requirement takes effect on July 1, 2010.

(j)(13)(ii) Manufacturers shall provide persons specified in paragraph (j)(3)(i) of this section with an efficient and cost-effective method for identifying whether the calibrations on engines are the latest to be issued. This requirement takes effect on July 1, 2010.

(j)(13)(iii) For all 2010 and later OBD engines equipped with reprogramming capability, manufacturers shall comply with either SAE J2534, "Recommended Practice for Pass-Thru Vehicle Programming", December 2004, or the Technology and Maintenance Council's (TMC) Recommended Practice RP1210A. "Windows™ Communication API", July 1999. These documents are Incorporated by Reference in §86.1.

(j)(13)(iv) For model years 2010 and later, manufacturers shall make available to aftermarket service providers the necessary manufacturer-specific software applications and calibrations needed to initiate pass-through reprogramming. This software shall be able to run on a standard

personal computer that utilizes standard operating systems as specified in either J2534 or RP1210A.

(j)(13)(v) Manufacturers may take any reasonable business precautions necessary to protect proprietary business information and are not required to provide this information to any party that does not agree to these reasonable business precautions. The requirements to make hardware available and to release the information to equipment and tool companies takes effect on July 1, 2010, and within 3 months of model introduction for all new model years.

(j)(14) *Generic and enhanced information for scan tools*. By July 1, 2010, manufacturers shall make available to equipment and tool companies all generic and enhanced service information including bi-directional control and data stream information as defined in paragraph (j)(4)(ii) of this section. This requirement applies for 2010 and later model year engines.

(j)(14)(i) The information required by this paragraph (j)(14) shall be provided electronically using common document formats to equipment and tool companies with whom they have appropriate licensing, contractual, and/or confidentiality arrangements. To the extent that a central repository for this information (e.g. the TEK-NET library developed by the Equipment and Tool Institute) is used to warehouse this information, the Administrator shall have free unrestricted access. In addition, information required by this paragraph (j)(14) shall be made available to equipment and tool companies who are not otherwise members of any central repository and shall have access if the non-members have arranged for the appropriate licensing, contractual and/or confidentiality arrangements with the manufacturer and/or a central repository.

(j)(14)(ii) In addition to the generic and enhanced information defined in paragraph (j)(3)(ii) of this section, manufacturers shall also make available the following information necessary for developing generic diagnostic scan tools:

(j)(14)(ii)(A) The physical hardware requirements for data communication (e.g. system voltage requirements, cable terminals/pins, connections such as RS232 or USB, wires, etc.)

(j)(14)(ii)(B) Electronic Control Unit (ECU) data communication (e.g. serial data protocols, transmission speed or baud rate, bit timing requirements, etc),

(j)(14)(ii)(C) Information on the application physical interface (API) or layers. (i.e., processing algorithms or software design descriptions for procedures such as connection, initialization, and termination),

(j)(14)(ii)(D) Engine application information or any other related service information such as special pins and voltages or additional connectors that require enablement and specifications for the enablement.

(j)(14)(iii) Any manufacturer who utilizes an automated process in their manufacturer-specific scan tool for diagnostic fault trees shall make available to equipment and tool companies the data schema, detail specifications, including category types/codes and codes, and data format/content structure of the diagnostic trouble trees.

(j)(14)(iv) Manufacturers can satisfy the requirement of paragraph (j)(14)(iii) of this section by making available diagnostic trouble trees on their manufacturer Web sites in full-text.

(j)(14)(v) Manufacturers shall make all required information available to the requesting equipment and tool company within 14 days after the request to purchase has been made unless the manufacturer requests Administrator approval to refuse to disclose such information to the requesting company or requests Administrator approval for additional time to comply. After receipt of a request and consultation with the affected parties, the Administrator shall either grant or refuse the petition based on the evidence submitted during the consultation process:

(j)(14)(v)(A) If the evidence demonstrates that the engine manufacturer has a reasonably based belief that the requesting equipment and tool company could not produce safe and functionally accurate tools that would not cause damage to the engine, the petition for non-disclosure will be granted. Engine manufacturers are not required to provide data stream and bi-directional control information that would permit an equipment and tool company's products to modify an EPA-certified engine or transmission configuration.

(j)(14)(v)(B) If the evidence does not demonstrate that the engine manufacturer has a reasonably-based belief that the requesting equipment and tool company could not produce safe and functionally accurate tools that would not cause damage to the engine, the petition for non-disclosure will be denied and the engine manufacturer, as applicable, shall make the requested information available to the requesting equipment and tool company within 2 days of the denial.

(j)(14)(vi) If the manufacturer submits a request for Administrator approval for additional time, and satisfactorily demonstrates to the Administrator that the engine manufacturer is able to comply but requires additional time within which to do so, the Administrator shall grant the request and provide additional time to fully and expeditiously comply.

(j)(14)(vii) Manufacturers may require that tools using information covered under paragraph (j)(14) of this section comply with the Component Identifier message specified in SAE J1939-71 as Parameter Group Number (PGN) 65249 (including the message parameter's make, model, and serial number) and the SAE J1939-81 Address Claim PGN.

(j)(15) *Availability of manufacturer-specific scan tools*. Manufacturers shall make available for sale to the persons specified in paragraph (j)(3)(i) of this section their own manufacturer-specific diagnostic tools at a fair and reasonable cost. These tools shall also be made available in a timely fashion either through the manufacturer Web site or through a manufacturer-designated intermediary. Manufacturers shall ship purchased tools in a timely manner after a request and training, if any, has been completed. Any required training materials and classes must be made available at a fair and reasonable price. Manufacturers who develop different versions of one or more of their diagnostic tools that are used in whole or in part for emission-related diagnosis and repair shall also insure that all emission-related diagnosis and repair information is available for sale to the aftermarket at a fair and reasonable cost. Factors for determining fair and reasonable cost include, but are not limited to:

(j)(15)(i) The net cost to the manufacturer's franchised dealerships for similar tools obtained from manufacturers, less any discounts, rebates, or other incentive programs;

(j)(15)(ii) The cost to the manufacturer for preparing and distributing the tools, excluding any research and development costs;

(j)(15)(iii) The price charged by other manufacturers of similar sizes for similar tools;

(j)(15)(iv) The capabilities and functionality of the manufacturer tool;

(j)(15)(v) The means by which the tools are distributed;

(j)(15)(vi) Inflation;

(j)(15)(vii) The ability of aftermarket technicians and shops to afford the tools. Manufacturers shall provide technical support to aftermarket service providers for the tools described in this section, either themselves or through a third-party of their choice.

(j)(16) *Changing content of manufacturer-specific scan tools*. Manufacturers who opt to remove non-emissions related content from their manufacturer-specific scan tools and sell them to the persons specified in paragraph (j)(3)(i) of this section shall adjust the cost of the tool accordingly lower to reflect the decreased value of the scan tool. All emissions-related content that remains in the manufacturer-specific tool shall be identical to the information that is contained in the complete version of the manufacturer specific tool. Any manufacturer who wishes to implement this option must request approval from the Administrator prior to the introduction of the tool into commerce.

(j)(17) *Reference Materials*. Manufacturers shall conform with the following Society of Automotive Engineers (SAE) standards. These documents are incorporated by reference in §86.1.

(j)(17)(i) For Web-based delivery of service information, manufacturers shall comply with SAE Recommended Practice J2403, Medium/Heavy-Duty E/E Systems Diagnosis Nomenclature; August 2004. This recommended practice standardizes various terms, abbreviations, and acronyms associated with on-board diagnostics. Manufacturers shall comply with SAE J2403 beginning with the Model Year 2013.

(j)(17)(ii) For identification and scaling information necessary to interpret and understand data available through Diagnostic Message 8, manufacturers shall comply with SAE Recommended Practice J1939-73, Application Layer – Diagnostics, revised June 2001. In the alternate, manufacturers may comply with Service/Mode $06 pursuant to SAE Recommended Practice J1979, E/E Diagnostic Test Modes – Equivalent to ISO/DIS 15031-5: April 30, 2002. These recommended practices describe the implementation of diagnostic test modes for emissions related test data. Manufacturers shall comply with either SAE J1939-73 or SAE J1979 beginning with Model Year 2013. These recommended practices describe the implementation of diagnostic test modes for emissions related test data.

(j)(17)(iii) For pass-thru reprogramming capabilities, manufacturers shall comply with Technology and Maintenance Council's (TMC) Recommended Practice RP1210A, "Windows™ Communication API", July 1999. In the alternate, manufacturers may comply with SAE J2534, Recommended Practice for Pass-Thru Vehicle Programming, December 2004. These recommended practices provide technical specifications and information that manufacturers must supply to equipment and tool companies to develop aftermarket pass-thru reprogramming tools. Manufacturers shall comply with either RP1210A or SAE J2534 beginning with Model Year 2013.

(j)(18) *Reporting Requirements*. Performance reports that adequately demonstrate that each manufacturers website meets the information requirements outlined in paragraphs (j)(6)(i) through (j)(6)(vi) of this section on shall be submitted to the Administrator annually or upon request by the Administrator. These reports shall indicate the performance and effectiveness of the websites by using commonly used Internet statistics (e.g. successful requests, frequency of use, number of subscriptions purchased, etc) Manufacturers shall provide to the Administrator reports on an annual basis within 30 days of the end of the calendar year. These annual reports shall be submitted to the Administrator electronically utilizing non-proprietary software in the format as agreed to by the Administrator and the manufacturers.

(j)(19) *Prohibited Acts, Liability and Remedies*.

(j)(19)(i) It is a prohibited act for any person to fail to promptly provide or cause a failure to promptly provide information as required by this paragraph (j), or to otherwise fail to comply or cause a failure to comply with any provision of this subsection.

(j)(19)(ii) Any person who fails or causes the failure to comply with any provision of this paragraph (j) is liable for a violation of that provision. A corporation is presumed liable for any violations of this subpart that are committed by any of its subsidiaries, affiliates or parents that are substantially owned by it or substantially under its control.

(j)(19)(iii) Any person who violates a provision of this paragraph (j) shall be subject to a civil penalty of not more than $ 31,500 per day for each violation. This maximum penalty is shown for calendar year 2002. Maximum penalty limits for later years may be set higher based on the Consumer Price Index, as specified in 40 CFR part 19. In addition, such person shall be liable for all other remedies set forth in Title II of the Clean Air Act, remedies pertaining to provisions of Title II of the Clean Air Act, or other applicable provisions of law.

§ 86.013-2 Definitions.

The definitions of §86.004–2 continue to apply to 2004 and later model year vehicles, and the definitions of §86.010-2 continue to apply to 2010 and later model year vehicles. The definitions listed in this section apply beginning with the 2013 model year.

Onboard Diagnostics (OBD) group means a combination of engines, engine families, or engine ratings that use the same OBD strategies and similar calibrations.

§ 86.013-17 On-board Diagnostics for engines used in applications less than or equal to 14,000 pounds GVWR.

Section 86.013–17 includes text that specifies requirements that differ from §86.005–17, §86.007–17, and §86.010–17. Where a paragraph in §86.005–17 or §86.007–17 or §86.010–17 is identical and applicable to §86.013–17, this may be indicated by specifying the corresponding paragraph and the statement "[Reserved]. For guidance see §86.005–17." or "[Reserved]. For guidance see §86.007–17." or "[Reserved]. For guidance see §86.010–17."

(a) General

(a) through (b)(1)(i) [Reserved]. For guidance see §86.010–17.

(b) Malfunction descriptions

(b)(1)(ii) *Diesel.*

(b)(1)(ii)(A) If equipped, reduction catalyst deterioration or malfunction before it results in exhaust NOx emissions exceeding the applicable NOx FEL+0.3 g/bhp-hr. If equipped, oxidation catalyst deterioration or malfunction before it results in exhaust NMHC emissions exceeding 2 times the applicable NMHC standard. These catalyst monitoring requirements need not be done if the manufacturer can demonstrate that deterioration or malfunction of the system will not result in exceedance of the threshold.

(b)(1)(ii)(B) If equipped, diesel particulate trap deterioration or malfunction before it results in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.04 g/bhp-hr or 0.05 g/bhp-hr PM, whichever is higher; or, exhaust NMHC emissions exceeding 2 times the applicable NMHC standard. Catastrophic failure of the particulate trap must also be detected. In addition, the absence of the particulate trap or the trapping substrate must be detected.

(b)(2) [Reserved]. For guidance see §86.005–17.

(b)(3)(i) *Oxygen sensors and air-fuel ratio sensors downstream of aftertreatment devices.*

(b)(3)(i)(A) *Otto-cycle*. If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding 1.5 times the applicable standard or FEL for NMHC, NOx or CO.

(b)(3)(i)(B) *Diesel.* If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.04 g/bhp-hr or 0.05 g/bhp-hr PM, whichever is higher; or, the applicable NOx FEL+0.3 g/bhp-hr; or, 2 times the applicable NMHC standard.

(b)(3)(ii) *Oxygen sensors and air-fuel ratio sensors upstream of aftertreatment devices*.

(b)(3)(ii)(A) *Otto-cycle.* If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding 1.5 times the applicable standard or FEL for NMHC, NOx or CO.

(b)(3)(ii)(B) *Diesel.* If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.02 g/bhp-hr or 0.03 g/bhp-hr PM, whichever is higher; or, the applicable NOx FEL+0.3 g/bhp-hr; or, 2 times the applicable NMHC standard; or, 2 times the applicable CO standard.

(b)(3)(iii) *NOx sensors.*

(b)(3)(iii)(A) *Otto-cycle.* If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding 1.5 times the applicable standard or FEL for NMHC, NOx or CO.

(b)(3)(iii)(B) *Diesel.* If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.04 g/bhp-hr or 0.05 g/bhp-hr PM, whichever is higher; or, the applicable NOx FEL+0.3 g/bhp-hr.

(b)(4) [Reserved]. For guidance see §86.005–17.

(b)(5) *Other emission control systems and components*.

(b)(5)(i) *Otto-cycle.* Any deterioration or malfunction occurring in an engine system or component directly intended to control emissions, including but not necessarily limited to, the exhaust gas recirculation (EGR) system, if equipped, the secondary air system, if equipped, and the fuel control system, singularly resulting in exhaust emissions exceeding 1.5 times the applicable emission standard or FEL for NMHC, NOx or CO. For engines equipped with a secondary air system, a functional check, as described in §86.005-17(b)(6), may satisfy the requirements of this paragraph (b)(5) provided the manufacturer can demonstrate that deterioration of the flow distribution system is unlikely. This demonstration is subject to Administrator approval and, if the demonstration and associated functional check are approved, the diagnostic system must indicate a malfunction when some degree of secondary airflow is not detectable in the exhaust system during the check. For engines equipped with positive crankcase ventilation (PCV), monitoring of the PCV system is not necessary provided the manufacturer can demonstrate to the Administrator's satisfaction that the PCV system is unlikely to fail.

(b)(5)(ii) *Diesel.* Any deterioration or malfunction occurring in an engine system or component directly intended to control emissions, including but not necessarily limited to, the exhaust gas recirculation (EGR) system, if equipped, and the fuel control system, singularly resulting in

exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.02 g/bhp-hr or 0.03 g/bhp-hr PM, whichever is higher; or, the applicable NOx FEL+0.3 g/bhp-hr; or, 2 times the applicable NMHC standard; or, 2 times the applicable CO standard. A functional check, as described in §86.005-17(b)(6), may satisfy the requirements of this paragraph (b)(5) provided the manufacturer can demonstrate that a malfunction would not cause emissions to exceed the applicable levels. This demonstration is subject to Administrator approval. For engines equipped with crankcase ventilation (CV), monitoring of the CV system is not necessary provided the manufacturer can demonstrate to the Administrator's satisfaction that the CV system is unlikely to fail.

(b)(6) through (j) [Reserved]. For guidance see §86.010–17.

(k) [Reserved.]

§ 86.013-18 On-board Diagnostics for engines used in applications greater than 14,000 pounds GVWR.

Section 86.013–18 includes text that specifies requirements that differ from §86.010–18. Where a paragraph in §86.010–18 is identical and applicable to §86.013–18, this may be indicated by specifying the corresponding paragraph and the statement "[Reserved]. For guidance see §86.010–18." However, where a paragraph in §86.010–18 is identical and applicable to §86.013–18, and there appears the statement "[Reserved]. For guidance see §86.010–18," it shall be understood that any referenced tables within §86.010-18 shall actually refer to the applicable table shown in §86.013-18.

(a) General

(a) *General*. All heavy-duty engines intended for use in a heavy-duty vehicle weighing more than 14,000 pounds GVWR must be equipped with an on-board diagnostic (OBD) system capable of monitoring all emission-related engine systems or components during the life of the engine. The OBD system is required to detect all malfunctions specified in paragraphs (g) and (i) of this section and paragraph (h) of §86.010-18 although the OBD system is not required to use a unique monitor to detect each of those malfunctions.

(a)(1) [Reserved]. For guidance see §86.010-18.

(a)(2) The OBD system must be equipped with a standardized data link connector to provide access to the stored DTCs as specified in paragraph (k)(2) of this section.

(a)(3) and (a)(4) [Reserved]. For guidance see §86.010-18.

(b) MIL and DTCs

(b) *Malfunction indicator light (MIL) and Diagnostic Trouble Codes (DTC)*. The OBD system must incorporate a malfunction indicator light (MIL) or equivalent and must store specific types of diagnostic trouble codes (DTC).

(b)(1) *MIL specifications*.

(b)(1)(i)The MIL must be located on the driver's side instrument panel and be of sufficient illumination and location to be readily visible under all lighting conditions. The MIL must be amber (yellow) in color; the use of red for the OBD-related MIL is prohibited. More than one general purpose malfunction indicator light for emission-related problems shall not be used; separate specific purpose warning lights (e.g., brake system, fasten seat belt, oil pressure, etc.) are permitted. When activated, the MIL must display the engine symbol designated as F01 by the International Standards Organization (ISO) in "Road vehicles -- Symbols for controls, indicators and tell-tales," ISO 2575:2004.

(b)(1)(ii) through (b)(1)(iv) [Reserved]. For guidance see §86.010-18.

(b)(1)(v) The MIL required by this paragraph (b) must not be used in any other way than is specified in this section.

(b)(2) [Reserved]. For guidance see §86.010-18.

(b)(3) *MIL deactivation and DTC erasure protocol*.

(b)(3)(i) *Deactivating the MIL*. Except as otherwise provided for in paragraph (g)(2)(iv)(E) of this section §86.010-18(g)(6)(iv)(B) for diesel misfire malfunctions and empty reductant tanks, and paragraphs (h)(1)(iv)(F), (h)(2)(viii), and (h)(7)(iv)(B) of §86.010-18 for gasoline fuel system, misfire, and evaporative system malfunctions, once the MIL has been activated, it may be deactivated after three subsequent sequential drive cycles during which the monitoring system responsible for activating the MIL functions and the previously detected malfunction is no longer present and provided no other malfunction has been detected that would independently activate the MIL according to the requirements outlined in §86.010-18(b)(2).

(b)(3)(ii) through (b)(4) [Reserved.] For guidance see §86.010-18.

(c) Monitoring conditions

(c) *Monitoring conditions*. The OBD system must monitor and detect the malfunctions specified in paragraphs (g) and (i) of this section and §86.010-18(h) under the following general monitoring conditions. The more specific monitoring conditions of paragraph (d) of this section are sometimes required according to the provisions of paragraphs (g) and (i) of this section and §86.010-18(h).

(c)(1) As specifically provided for in paragraphs (g) and (i) of this section and §86.010-18(h), the monitoring conditions for detecting malfunctions must be technically necessary to ensure robust detection of malfunctions (e.g., avoid false passes and false indications of malfunctions); designed to ensure monitoring will occur under conditions that may reasonably be expected to be encountered in normal vehicle operation and normal vehicle use; and, designed to ensure monitoring will occur during the FTP transient test cycle contained in Appendix I paragraph (f), of this part, or similar drive cycle as approved by the Administrator.

(c)(2) [Reserved]. For guidance see §86.010-18.

(c)(3) Manufacturers may request approval to define monitoring conditions that are not encountered during the FTP cycle as required in paragraph (c)(1) of this section. In evaluating the manufacturer's request, the Administrator will consider the degree to which the requirement to run during the FTP transient cycle restricts monitoring during in-use operation, the technical necessity for defining monitoring conditions that are not encountered during the FTP cycle, data and/or an engineering evaluation submitted by the manufacturer that demonstrate that the component/system does not normally function during the FTP, whether monitoring is otherwise not feasible during the FTP cycle, and/or the ability of the manufacturer to demonstrate that the monitoring conditions satisfy the minimum acceptable in-use monitor performance ratio requirement as defined in paragraph (d)(1)(ii) of this section.

(d) In-use performance tracking

(d) through (d)(1)(i) [Reserved]. For guidance see §86.010-18.

(d)(1)(ii) Manufacturers must define monitoring conditions that, in addition to meeting the criteria in paragraph (c)(1) of this section and §86.010-18(d) through (d)(1)(i), ensure that the monitor yields an in-use performance ratio (as defined in §86.010-18(d)(2)) that meets or exceeds the minimum acceptable in-use monitor performance ratio of 0.100 for all monitors specifically required in paragraphs (g) and (i) of this section and §86.010-18(h) to meet the monitoring condition requirements in §86.010-18(d)(1)(i).

(d)(1)(iii) If the most reliable monitoring method developed requires a lower ratio for a specific monitor than that specified in paragraph (d)(1)(ii) of this section, the Administrator may lower the minimum acceptable in-use monitoring performance ratio.

(d)(2) through (d)(3)(iv) [Reserved]. For guidance see §86.010-18.

(d)(3)(v) Manufacturers that use alternative statistical MIL activation protocols as allowed in §86.010-18(b)(2)(iii) for any of the monitors requiring a numerator, are required to increment the numerator(s) appropriately. The manufacturer may be required to provide supporting data and/or engineering analyses demonstrating both the equivalence of their incrementing approach to the incrementing specified in this paragraph (d)(3) for monitors using the standard MIL activation protocol, and the overall equivalence of the incrementing approach in determining that the

minimum acceptable in-use performance ratio of paragraph (d)(1)(ii) of this section has been satisfied.

(d)(4) through (f) [Reserved]. For guidance see §86.010-18.

(e) Standardized tracking and reporting of in-use monitor performance

(e) [Reserved]. For guidance see §86.010-18.

(f) Malfunction criteria determination

(f) [Reserved]. For guidance see §86.010-18.

(g) OBD monitoring requirements for diesel-fueled/CI engines

(g) *OBD monitoring requirements for diesel-fueled/compression-ignition engines*. The following table shows the thresholds at which point certain components or systems, as specified in this paragraph (g), are considered malfunctioning.

Table 1. OBD Emissions Thresholds for Diesel-Fueled/Compression Ignition Engines meant for Engines Placed in Applications Greater than 14,000 Pounds GVWR (g/bhp-hr)

Component	§86.013-18 reference	NMHC	CO	NOx	PM
NMHC catalyst system	(g)(5)	2x	--	--	--
NOx aftertreatment system	(g)(6) (g)(7)	--	--	+0.3	--
Diesel particulate filter (DPF) system	(g)(8)	2x	--	--	0.05/+0.04
Air-fuel ratio sensors upstream of aftertreatment devices	(g)(9)	2x	2x	+0.3	0.03/+0.02
Air-fuel ratio sensors downstream of aftertreatment devices	(g)(9)	2x	--	+0.3	0.05/+0.04
NOx sensors	(g)(9)	--	--	+0.3	0.05/+0.04
"Other monitors" with emissions thresholds	(g)(1) (g)(2) (g)(3) (g)(4) (g)(10)	2x	2x	+0.3	0.03/+0.02

Notes: FEL=Family Emissions Limit; 2x std means a multiple of 2 times the applicable emissions standard; +0.3 means the standard or FEL plus 0.3; 0.05/+0.04 means an absolute level of 0.05 or an additive level of the standard or FEL plus 0.04, whilchever level is higher; these emissions thresholds apply to the monitoring requirements of paragraph (g) of this section 86.013-18.

(g)(1) Fuel system

(g)(1) *Fuel system monitoring*.

(g)(1)(i) through (g)(1)(iii)(A) [Reserved]. For guidance see §86.010-18.

(g)(1)(iii)(B) The manufacturer must define the monitoring conditions for malfunctions identified in §86.010-18(g)(1)(ii)(B) and (g)(1)(ii)(C) and Table 1 of paragraph (g) of this section in accordance with paragraphs (c) and (d) of this section.

(g)(1)(iv) *Fuel system MIL activation and DTC storage*. The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(g)(2) Engine misfire

(g)(2) *Engine misfire monitoring*.

(g)(2)(i) [Reserved]. For guidance see §86.010-18.

(g)(2)(ii) *Engine misfire malfunction criteria*.

(g)(2)(ii)(A) The OBD system must be capable of detecting misfire occurring in one or more cylinders. To the extent possible without adding hardware for this specific purpose, the OBD system must also identify the specific misfiring cylinder. If more than one cylinder is continuously misfiring, a separate DTC must be stored indicating that multiple cylinders are misfiring. When identifying multiple cylinder misfire, the OBD system is not required to identify individually through separate DTCs each of the continuously misfiring cylinders.

(g)(2)(ii)(B) On engines equipped with sensors that can detect combustion or combustion quality (e.g., for use in engines with homogeneous charge compression ignition (HCCI) control systems), the OBD system must detect a misfire malfunction causing emissions to exceed the applicable thresholds for "other monitors" shown in Table 1 of this paragraph (g). To determine what level of misfire would cause emissions to exceed the applicable emissions thresholds, the manufacturer must determine the percentage of misfire evaluated in 1,000 revolution increments that would cause emissions from an emission durability demonstration engine to exceed the emissions thresholds if the percentage of misfire were present from the beginning of the test. To establish this percentage of misfire, the manufacturer must use misfire events occurring at equally spaced, complete engine cycle intervals, across randomly selected cylinders throughout each 1,000-revolution increment. If this percentage of misfire is determined to be lower than one percent, the manufacturer may set the malfunction criteria at one percent. Any misfire malfunction must be detected if the percentage of misfire established via this testing is exceeded regardless of the pattern of misfire events (e.g., random, equally spaced, continuous). The manufacturer may employ other revolution increments besides the 1,000 revolution increment. To do so, the manufacturer must demonstrate that the strategy is equally effective and timely in detecting misfire.

(g)(2)(iii) *Engine misfire monitoring conditions*.

(g)(2)(iii)(A) and (g)(2)(iii)(B) [Reserved]. For guidance see §86.010-18.

(g)(2)(iii)(C) For engines equipped with sensors that can detect combustion or combustion quality the OBD system must monitor continuously for engine misfire under all positive torque engine speed and load conditions. If a monitoring system cannot detect all misfire patterns under all required engine speed and load conditions, the manufacturer may request that the Administrator approve the monitoring system nonetheless. In evaluating the manufacturer's request, the Administrator will consider the following factors: the magnitude of the region(s) in which misfire detection is limited; the degree to which misfire detection is limited in the region(s) (i.e., the probability of detection of misfire events); the frequency with which said region(s) are expected to be encountered in-use; the type of misfire patterns for which misfire detection is troublesome; and demonstration that the monitoring technology employed is not inherently incapable of detecting misfire under required conditions (i.e., compliance can be achieved on other engines). The evaluation will be based on the following misfire patterns: equally spaced misfire occurring on randomly selected cylinders; single cylinder continuous misfire; and, paired cylinder (cylinders firing at the same crank angle) continuous misfire.

(g)(2)(iv) *Engine misfire MIL activation and DTC storage*.

(g)(2)(iv)(A) General requirements for MIL activation and DTC storage are set forth in paragraph (b) of this section.

(g)(2)(iv)(B) For engines equipped with sensors that can detect combustion or combustion quality, upon detection of the percentage of misfire specified in paragraph (g)(2)(ii)(B) of this section, the following criteria shall apply for MIL activation and DTC storage: A pending DTC must be stored no later than after the fourth exceedance of the percentage of misfire specified in paragraph (g)(2)(ii) of this section during a single drive cycle; if a pending fault code has been stored, the OBD system must activate the MIL and store a MIL-on DTC within 10 seconds if the percentage of misfire specified in paragraph (g)(2)(ii) of this section is again exceeded four times during the drive cycle immediately following storage of the pending DTC, regardless of the conditions encountered during the drive cycle, or on the next drive cycle in which similar conditions are encountered to those that were occurring when the pending DTC was stored. Similar conditions means an engine speed within 375 rpm, engine load within 20 percent, and the same warm up status (i.e., cold or hot). The Administrator may approve other definitions of similar conditions based on comparable timeliness and reliability in detecting similar engine

operation. The pending DTC may be erased at the end of the next drive cycle in which similar conditions are encountered to those that were occurring when the pending DTC was stored provided the specified percentage of misfire was not again exceeded. The pending DTC may also be erased if similar conditions are not encountered during the 80 drive cycles immediately following initial detection of the malfunction.

(g)(2)(iv)(C) For engines equipped with sensors that can detect combustion or combustion quality, the OBD system must store and erase freeze frame conditions either in conjunction with storing and erasing a pending DTC or in conjunction with storing and erasing a MIL-on DTC. If freeze frame conditions are stored for a malfunction other than a misfire malfunction when a DTC is stored as specified in paragraph (g)(2)(iv)(B) of this section, the stored freeze frame information must be replaced with the freeze frame information regarding the misfire malfunction.

(g)(2)(iv)(D) For engines equipped with sensors that can detect combustion or combustion quality, upon detection of misfire according to paragraph (g)(2)(iv)(B) of this section, the OBD system must also store the following engine conditions: engine speed, load, and warm up status of the first misfire event that resulted in the storage of the pending DTC.

(g)(2)(iv)(E) For engines equipped with sensors that can detect combustion or combustion quality, the MIL may be deactivated after three sequential drive cycles in which similar conditions have been encountered without an exceedance of the specified percentage of misfire.

(g)(3) EGR system

(g)(3) *EGR system monitoring*.

(g)(3)(i) and (g)(3)(ii) [Reserved]. For guidance see §86.010-18.

(g)(3)(iii) *EGR system monitoring conditions*.

(g)(3)(iii)(A) [Reserved]. For guidance see §86.010-18.

(g)(3)(iii)(B) The manufacturer must define the monitoring conditions for malfunctions identified in §86.010-18(g)(3)(ii)(C) and Table 1 of paragraph (g) of this section in accordance with paragraphs (c) and (d) of this section, with the exception that monitoring must occur every time the monitoring conditions are met during the drive cycle rather than once per drive cycle as required in §86.010-18(c)(2). For purposes of tracking and reporting as required in §86.010-18(d) through (d)(1)(i), all monitors used to detect malfunctions identified in §86.010-18(g)(3)(ii)(C) and Table 1 of paragraph (g) of this section must be tracked separately but reported as a single set of values as specified in §86.010-18(e)(1)(iii).

(g)(3)(iii)(C) The manufacturer must define the monitoring conditions for malfunctions identified in §86.010-18(g)(3)(ii)(E) and Table 1 of paragraph (g) of this section in accordance with paragraphs (c) and (d) of this section. For purposes of tracking and reporting as required in §86.010-18(d) through (d)(1)(i), all monitors used to detect malfunctions identified in §86.010-18(g)(3)(ii)(E) and Table 1 of paragraph (g) of this section must be tracked separately but reported as a single set of values as specified in §86.010-18(e)(1)(iii).

(g)(3)(iii)(D) [Reserved]. For guidance see §86.010-18.

(g)(3)(iv) *EGR system MIL activation and DTC storage*. The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(g)(4) Turbo boost control system

(g)(4) *Turbo boost control system monitoring*.

(g)(4)(i) and (g)(4)(ii) [Reserved]. For guidance see §86.010-18.

(g)(4)(iii) *Turbo boost control system monitoring conditions*.

(g)(4)(iii)(A) [Reserved]. For guidance see §86.010-18.

(g)(4)(iii)(B) The manufacturer must define the monitoring conditions for malfunctions identified in §86.010-18(g)(4)(ii)(C) and Table 1 of paragraph (g) of this section in accordance with paragraphs (c) and (d) of this section, with the exception that monitoring must occur every time the monitoring conditions are met during the drive cycle rather than once per drive cycle as required in §86.010-18(c)(2). For purposes of tracking and reporting as required in §86.010-18(d) through (d)(1)(i), all monitors used to detect malfunctions identified in §86.010-18(g)(4)(ii)(C) and Table 1 of paragraph (g) of this section must be tracked separately but reported as a single set of values as specified in §86.010-18(e)(1)(iii).

(g)(4)(iii)(C) The manufacturer must define the monitoring conditions for malfunctions identified in §86.010-18(g)(4)(ii)(E) and Table 1 of paragraph (g) of this section in accordance

with paragraphs (c) and (d) of this section. For purposes of tracking and reporting as required in §86.010-18(d) through (d)(1)(i), all monitors used to detect malfunctions identified in §86.010-18(g)(4)(ii)(E) and Table 1 of paragraph (g) of this section must be tracked separately but reported as a single set of values as specified in §86.010-18(e)(1)(iii).

(g)(4)(iv) *Turbo boost system MIL activation and DTC storage*. The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(g)(5) NMHC catalyst

(g)(5) *NMHC converting catalyst monitoring*.

(g)(5)(i) and (g)(5)(ii) [Reserved]. For guidance see §86.010-18.

(g)(5)(iii) *NMHC converting catalyst monitoring conditions*. The manufacturer must define the monitoring conditions for malfunctions identified in §86.010-18(g)(5)(ii)(A) and (g)(5)(ii)(B) and Table 1 of paragraph (g) of this section in accordance with paragraphs (c) and (d) of this section. For purposes of tracking and reporting as required in §86.010-18(d) through (d)(1)(i), all monitors used to detect malfunctions identified in §86.010-18(g)(5)(ii)(A) and (g)(5)(ii)(B) and Table 1 of paragraph (g) of this section must be tracked separately but reported as a single set of values as specified in §86.010-18(e)(1)(iii).

(g)(5)(iv) *NMHC converting catalyst MIL activation and DTC storage*. The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section. The monitoring method for the NMHC converting catalyst(s) must be capable of detecting all instances, except diagnostic self-clearing, when a catalyst DTC has been erased but the catalyst has not been replaced (e.g., catalyst over-temperature histogram approaches are not acceptable).

(g)(6) SCR & lean NOx catalyst

(g)(6) *Selective catalytic reduction (SCR) and lean NOx catalyst monitoring*.

(g)(6)(i) and (g)(6)(ii) [Reserved]. For guidance see §86.010-18

(g)(6)(iii) *SCR and lean NOx catalyst monitoring conditions*.

(g)(6)(iii)(A) The manufacturers must define the monitoring conditions for malfunctions identified in §86.010-18(g)(6)(ii)(A) and Table 1 of paragraph (g) of this section in accordance with paragraphs (c) and (d) of this section. For purposes of tracking and reporting as required in §86.010-18(d) through (d)(1)(i), all monitors used to detect malfunctions identified in §86.010-18(g)(6)(ii)(A) and Table 1 of paragraph (g) of this section must be tracked separately but reported as a single set of values as specified in §86.010-18(e)(1)(iii).

(g)(6)(iii)(B) [Reserved]. For guidance see §86.010-18.

(g)(6)(iv) *SCR and lean NOx catalyst MIL activation and DTC storage*.

(g)(6)(iv)(A) For malfunctions identified in §86.010-18(g)(6)(ii)(A) and Table 1 of paragraph (g) of this section , the MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(g)(6)(iv)(B) and (g)(6)(iv)(C) [Reserved]. For guidance see §86.010-18.

(g)(7) NOx adsorber system

(g)(7) *NOx adsorber system monitoring*.

(g)(7)(i) and (g)(7)(ii) [Reserved]. For guidance see §86.010-18.

(g)(7)(iii) *NOx adsorber system monitoring conditions*.

(g)(7)(iii)(A) The manufacturer must define the monitoring conditions for malfunctions identified in §86.010-18(g)(7)(ii)(A) and Table 1 of paragraph (g) of this section in accordance with paragraphs (c) and (d) of this section. For purposes of tracking and reporting as required in §86.010-18(d) through (d)(1)(i), all monitors used to detect malfunctions identified in §86.010-18(g)(7)(ii)(A) and Table 1 of paragraph (g) of this section must be tracked separately but reported as a single set of values as specified in of §86.010-18(e)(1)(iii).

(g)(7)(iii)(B) [Reserved]. For guidance see §86.010-18.

(g)(7)(iv) *NOx adsorber system MIL activation and DTC storage*. The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(g)(8) DPF system

(g)(8) *Diesel particulate filter (DPF) system monitoring*.

(g)(8)(i) and (g)(8)(ii) [Reserved]. For guidance see §86.010-18.

(g)(8)(iii) *DPF monitoring conditions*. The manufacturer must define the monitoring conditions for malfunctions identified in §86.010-18(g)(8)(ii) and Table 1 of paragraph (g) of this section in accordance with paragraphs (c) and (d) of this section, with the exception that monitoring must occur every time the monitoring conditions are met during the drive cycle rather than once per drive cycle as required in §86.010-18(c)(2). For purposes of tracking and reporting as required in §86.010-18(d) through (d)(1)(i), all monitors used to detect malfunctions identified in §86.010-18(g)(8)(ii) and Table 1 of paragraph (g) of this section must be tracked separately but reported as a single set of values as specified in §86.010-18(e)(1)(iii).

(g)(8)(iv) *DPF system MIL activation and DTC storage*. The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(g)(9) Exhaust gas sensors

(g)(9) *Exhaust gas sensor and sensor heater monitoring*.

(g)(9)(i) through (g)(9)(vi) [Reserved]. For guidance see §86.010-18.

(g)(9)(vii) *Monitoring conditions for exhaust gas sensors*.

(g)(9)(vii)(A) The manufacturer must define the monitoring conditions for malfunctions identified in §86.010-18(g)(9)(ii)(A), (g)(9)(iii)(A), and (g)(9)(iv)(A) (i.e., sensor performance) and Table 1 of paragraph (g) of this section in accordance with paragraphs (c) and (d) of this section. For purposes of tracking and reporting as required in §86.010-18(d) through (d)(1)(i), all monitors used to detect malfunctions identified in §86.010-18 (g)(9)(ii)(A), (g)(9)(iii)(A), and (g)(9)(iv)(A) and Table 1 of paragraph (g) of this section must be tracked separately but reported as a single set of values as specified in §86.010-18(e)(1)(iii).

(g)(9)(vii)(B) The manufacturer must define the monitoring conditions for malfunctions identified in §86.010-18(g)(9)(ii)(D), (g)(9)(iii)(D), and (g)(9)(iv)(D) (i.e., monitoring function) and Table 1 of paragraph (g) of this section in accordance with paragraphs (c) and (d) of this section with the exception that monitoring must occur every time the monitoring conditions are met during the drive cycle rather than once per drive cycle as required in §86.010-18(c)(2).

(g)(9)(vii)(C) and (g)(9)(vii)(D) [Reserved]. For guidance see §86.010-18.

(g)(9)(viii) *Monitoring conditions for exhaust gas sensor heaters*.

(g)(9)(viii)(A) The manufacturer must define monitoring conditions for malfunctions identified in §86.010-18(g)(9)(vi)(A) (i.e., sensor heater performance) and Table 1 of paragraph (g) of this section in accordance with paragraphs (c) and (d) of this section.

(g)(9)(viii)(B) [Reserved]. For guidance see §86.010-18.

(g)(9)(ix) *Exhaust gas sensor and sensor heater MIL activation and DTC storage*. The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(g)(10) VVT system

(g)(10) *Variable valve timing (VVT) system monitoring*.

(g)(10)(i) and (g)(10)(ii) [Reserved]. For guidance see §86.010-18.

(g)(10)(iii) *VVT system monitoring conditions*. Manufacturers must define the monitoring conditions for VVT system malfunctions identified in §86.010-18(g)(10)(ii) and Table 1 of paragraph (g) of this section in accordance with paragraphs (c) and (d) of this section, with the exception that monitoring must occur every time the monitoring conditions are met during the drive cycle rather than once per drive cycle as required in §86.010-18(c)(2). For purposes of tracking and reporting as required in §86.010-18(d) through (d)(1)(i), all monitors used to detect malfunctions identified in §86.010-18(g)(10)(ii) and Table 1 of paragraph (g) of this section must be tracked separately but reported as a single set of values as specified in §86.010-18(e)(1)(iii).

(g)(10)(iv) *VVT MIL activation and DTC storage*. The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(h) Monitoring requirements for gasoline-fueled/SI engines

(h) [Reserved]. For guidance see §86.010-18.

(i) Monitoring requirements for all engines

(i) *OBD monitoring requirements for all engines*.

(i)(1) Cooling system

(i)(1) *Engine cooling system monitoring*.

(i)(1)(i) through (i)(1)(iii) [Reserved]. For guidance see §86.010-18.

(i)(1)(iv) *Monitoring conditions for the thermostat*.

(i)(1)(iv)(A) The manufacturer must define the monitoring conditions for malfunctions identified in §86.010-18(i)(1)(ii)(A) and Table 1 of paragraph (g) of this section in accordance with paragraph (c) of this section. Additionally, except as provided for in §86.010-18(i)(1)(iv)(B) and (i)(1)(iv)(C), monitoring for malfunctions identified in §86.010-18(i)(1)(ii)(A) and Table 1 of paragraph (g) of this section must be conducted once per drive cycle on every drive cycle in which the ECT sensor indicates, at engine start, a temperature lower than the temperature established as the malfunction criteria in §86.010-18(i)(1)(ii)(A) and Table 1 of paragraph (g) of this section.

(i)(1)(iv)(B) and (i)(1)(iv)(C) [Reserved]. For guidance see §86.010-18.

(i)(1)(v) *Monitoring conditions for the ECT sensor*.

(i)(1)(v)(A) [Reserved]. For guidance see §86.010-18.

(i)(1)(v)(B) The manufacturer must define the monitoring conditions for malfunctions identified in §86.010-18(i)(1)(iii)(B) and Table 1 of paragraph (g) of this section in accordance with paragraph (c) of this section. Additionally, except as provided for in §86.010-18(i)(1)(v)(D), monitoring for malfunctions identified in §86.010-18(i)(1)(iii)(B) and Table 1 of paragraph (g) of this section must be conducted once per drive cycle on every drive cycle in which the ECT sensor indicates a temperature lower than the closed-loop enable temperature at engine start (i.e., all engine start temperatures greater than the ECT sensor out-of-range low temperature and less than the closed-loop enable temperature).

(i)(1)(v)(C) The manufacturer must define the monitoring conditions for malfunctions identified in §86.010-18(i)(1)(iii)(C) and (i)(1)(iii)(D) and Table 1 of paragraph (g) of this section in accordance with paragraphs (c) and (d) of this section.

(i)(1)(v)(D) and (i)(1)(v)(E) [Reserved]. For guidance see §86.010-18.

(i)(1)(vi) *Engine cooling system MIL activation and DTC storage*. The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(i)(2) Crankcase ventilation system

(i)(2) *Crankcase ventilation (CV) system monitoring*.

(i)(2)(i) and (i)(2)(ii) [Reserved]. For guidance see §86.010-18.

(i)(2)(iii) *Crankcase ventilation system monitoring conditions*. The manufacturer must define the monitoring conditions for malfunctions identified in §86.010-18 (i)(2)(ii) and Table 1 of paragraph (g) of this section in accordance with paragraphs (c) and (d) of this section.

(i)(2)(iv) *Crankcase ventilation system MIL activation and DTC storage*. The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section. The stored DTC need not identify specifically the CV system (e.g., a DTC for idle speed control or fuel system monitoring can be stored) if the manufacturer can demonstrate that additional monitoring hardware would be necessary to make such an identification and provided the manufacturer's diagnostic and repair procedures for the detected malfunction include directions to check the integrity of the CV system.

(i)(3) Comprehensive components

(i)(3) *Comprehensive component monitoring*.

(i)(3)(i) *General*. Except as provided for in paragraph (i)(4) of this section, the OBD system must detect a malfunction of any electronic engine component or system not otherwise described in paragraphs (g), (i)(1), and (i)(2) of this section and §86.010-18(h) that either provides input to (directly or indirectly, such components may include the crank angle sensor, knock sensor, throttle position sensor, cam position sensor, intake air temperature sensor, boost pressure sensor, manifold pressure sensor, mass air flow sensor, exhaust temperature sensor, exhaust pressure sensor, fuel pressure sensor, fuel composition sensor of a flexible fuel vehicle, etc.) or receives commands from (such components or systems may include the idle speed control system, glow plug system, variable length intake manifold runner systems, supercharger or turbocharger electronic components, heated fuel preparation systems, the wait-to-start lamp on diesel applications, the MIL, etc.) the onboard computer(s) and meets either of the criteria

described in §86.010-18(i)(3)(i)(A) and/or (i)(3)(i)(B). Note that, for the purposes of this paragraph (i)(3), "electronic engine component or system" does not include components that are driven by the engine and are not related to the control of the fueling, air handling, or emissions of the engine (e.g., PTO components, air conditioning system components, and power steering components).

(i)(3)(i)(A) through (i)(3)(iii) [Reserved]. For guidance see §86.010-18.

(i)(3)(iv) *Monitoring conditions for input components*.

(i)(3)(iv)(A) [Reserved]. For guidance see §86.010-18.

(i)(3)(iv)(B) For input component rationality checks (where applicable), the manufacturer must define the monitoring conditions for detecting malfunctions in accordance with paragraphs (c) and (d) of this section, with the exception that rationality checks must occur every time the monitoring conditions are met during the drive cycle rather than once per drive cycle as required in §86.010-18(c)(2).

(i)(3)(v) *Monitoring conditions for output components/systems*.

(i)(3)(v)(A) [Reserved]. For guidance see §86.010-18.

(i)(3)(v)(B) For output component/system functional checks, the manufacturer must define the monitoring conditions for detecting malfunctions in accordance with paragraphs (c) and (d) of this section. Specifically for the idle control system, the manufacturer must define the monitoring conditions for detecting malfunctions in accordance with paragraphs (c) and (d) of this section, with the exception that functional checks must occur every time the monitoring conditions are met during the drive cycle rather than once per drive cycle as required in §86.010-18(c)(2).

(i)(3)(vi) *Comprehensive component MIL activation and DTC storage*.

(i)(3)(vi)(A) Except as provided for in §86.010-18(i)(3)(vi)(B) and (i)(3)(vi)(C), the MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(i)(3)(vi)(B) and (i)(3)(vi)(C) [Reserved]. For guidance see §86.010-18.

(i)(4) Other emission control systems

(i)(4) *Other emission control system monitoring*.

(i)(4)(i) *General*. For other emission control systems that are either not addressed in §86.010-18(h) and paragraphs (g) and (i)(1) through (i)(3) of this section (e.g., hydrocarbon traps, homogeneous charge compression ignition control systems), or addressed in paragraph (i)(3) of this section but not corrected or compensated for by an adaptive control system (e.g., swirl control valves), the manufacturer must submit a plan for Administrator approval of the monitoring strategy, malfunction criteria, and monitoring conditions prior to introduction on a production engine. The plan must demonstrate the effectiveness of the monitoring strategy, the malfunction criteria used, the monitoring conditions required by the monitor, and, if applicable, the determination that the requirements of §86.010-18(i)(4)(ii) are satisfied.

(i)(4)(ii) [Reserved]. For guidance see §86.010-18.

(i)(5) Exceptions to monitoring requirements

(i)(5) [Reserved]. For guidance see §86.010-18.

(i)(6) Feedback control system

(i)(6) *Feedback control system monitoring*. If the engine is equipped with feedback control of any of the systems covered in paragraphs (g) and (i) of this section and §86.010-18(h), then the OBD system must detect as malfunctions the conditions specified in this paragraph (i)(6) for each of the individual feedback controls.

(i)(6)(i) through (i)(6)(iv) [Reserved]. For guidance see §86.010-18.

(j) Production evaluation testing

(j) *Production evaluation testing*.

(j)(1) *Verification of standardization requirements*.

(j)(1)(i) The manufacturer must perform testing to verify that production vehicles meet the requirements of paragraphs (k)(3) and (k)(4) of this section relevant to the proper communication of required emissions-related messages to a SAE J1978/J1939 scan tool.

(j)(1)(ii) *Selection of test vehicles*.

(j)(1)(ii)(A) The manufacturer must perform this testing every model year on ten unique production vehicles (i.e., engine rating and chassis application combination) per engine family. If there are less than ten unique production vehicles for a certain engine family, the manufacturer must test each unique production vehicle in that engine family. The manufacturer must perform this testing within either three months of the start of engine production or one month of the start of vehicle production, whichever is later. The manufacturer may request approval to group multiple production vehicles together and test one representative vehicle per group. To do so, the software and hardware designed to comply with the standardization requirements of paragraph (k) of this section (e.g., communication protocol message timing, number of supported data stream parameters, engine and vehicle communication network architecture) in the representative vehicle must be identical to all others in the group and any differences in the production vehicles cannot be relevant with respect to meeting the criteria of paragraph (j)(1)(iv) of this section.

(j)(1)(ii)(B) For 2016 and subsequent model years, the required number of vehicles to be tested shall be reduced to five per engine family provided zero vehicles fail the testing required by paragraph (j)(1) of this section for two consecutive years.

(j)(1)(ii)(C) For 2019 and subsequent model years, the required number of vehicles to be tested shall be reduced to three per engine family provided zero vehicles fail the testing required by paragraph (j)(1) of this section for three consecutive years.

(j)(1)(ii)(D) The requirement for submittal of data from one or more of the production vehicles shall be waived if data have been submitted previously for all of the production vehicles. The manufacturer may request approval to carry over data collected in previous model years. To do so, the software and hardware designed to comply with the standardization requirements of paragraph (k) of this section must be identical to the previous model year and there must not have been other hardware or software changes that affect compliance with the standardization requirements.

(j)(1)(iii) *Test equipment*. For the testing required by paragraph (j)(1) of this section, the manufacturer shall use an off-board device to conduct the testing. The manufacturer must be able to show that the off-board device is able to verify that the vehicles tested using the device are able to perform all of the required functions in paragraph (j)(1)(iv) of this section with any other off-board device designed and built in accordance with the SAE J1978/J1939 generic scan tool specifications.

(j)(1)(iv) *Required testing*. The testing must verify that communication can be established properly between all emission-related on-board computers and any SAE J1978/J1939 scan tool designed to adhere strictly to the communication protocols allowed in paragraph (k)(3) of this section. The testing must also verify that all emission-related information is communicated properly between all emission-related on-board computers and any SAE J1978/J1939 scan tool in accordance with the requirements of paragraph (k) of this section and the applicable ISO and SAE specifications including specifications for physical layer, network layer, message structure, and message content. The testing must also verify that the onboard computer(s) can properly respond to any SAE J1978/J1939 scan tool request to clear emissions-related DTCs and reset the ready status in accordance with paragraph (k)(4)(ix) of this section. The testing must further verify that the following information can be properly communicated to any SAE J1978/J1939 scan tool:

(j)(1)(iv)(A) The current ready status from all onboard computers required to support ready status in accordance with SAE J1978/J1939-73 and paragraph (k)(4)(i) of this section in the key-on, engine-off position and while the engine is running.

(j)(1)(iv)(B) The MIL command status while a deactivated MIL is commanded and while an activated MIL is commanded in accordance with SAE J1979/J1939 and paragraph (k)(4)(ii) of this section in the key-on, engine-off position and while the engine is running, and in accordance with SAE J1979/J1939 and §86.010-18(b)(1)(ii) during the MIL functional check and, if applicable, (k)(4)(i)(C) of this section during the MIL ready status check while the engine is off.

(j)(1)(iv)(C) All data stream parameters required in paragraph (k)(4)(ii) of this section in accordance with SAE J1979/J1939 including, if applicable, the proper identification of each data stream parameter as supported in SAE J1979 (e.g., Mode/Service $01, PID $00).

(j)(1)(iv)(D) The CAL ID, CVN, and VIN as required by paragraphs (k)(4)(vi), (k)(4)(vii), and (k)(4)(viii) of this section and in accordance with SAE J1979/J1939.

(j)(1)(iv)(E) An emissions-related DTC (permanent, pending, MIL-on, previous-MIL-on) in accordance with SAE J1979/J1939-73 (including the correct indication of the number of stored DTCs (e.g., Mode/Service $01, PID $01, Data A for SAE J1979)) and paragraph (k)(4)(iv) of this section.

(j)(1)(v) *Reporting of results*. The manufacturer must submit to the Administrator the following, based on the results of the testing required by paragraph (j)(1)(iv) of this section:

(j)(1)(v)(A) If a variant meets all the requirements of paragraph (j)(1)(iv) of this section, a statement specifying that the variant passed all the tests. Upon request from the Administrator, the detailed results of any such testing may have to be submitted.

(j)(1)(v)(B) If any variant does not meet the requirements of paragraph (j)(1)(iv) of this section, a written report detailing the problem(s) identified and the manufacturer's proposed corrective action (if any) to remedy the problem(s). This report must be submitted within one month of testing the specific variant. The Administrator will consider the proposed remedy and, if in disagreement, will work with the manufacturer to propose an alternative remedy. Factors to be considered by the Administrator in considering the proposed remedy will include the severity of the problem(s), the ability of service technicians to access the required diagnostic information, the impact on equipment and tool manufacturers, and the amount of time prior to implementation of the proposed corrective action.

(j)(1)(vi) *Alternative testing protocols*. Manufacturers may request approval to use other testing protocols. To do so, the manufacturer must demonstrate that the alternative testing methods and equipment will provide an equivalent level of verification of compliance with the standardization requirements as is required by paragraph (j)(1) of this section.

(j)(2) *Verification of monitoring requirements*.

(j)(2)(i) through (j)(2)(ii)(C) [Reserved]. For guidance see §86.010-18.

(j)(2)(iii) *Evaluation requirements*.

(j)(2)(iii)(A) The evaluation must demonstrate the ability of the OBD system on the selected test vehicle to detect a malfunction, activate the MIL, and, where applicable, store an appropriate DTC readable by a SAE J1978/J1939 scan tool when a malfunction is present and the monitoring conditions have been satisfied for each individual monitor required by this section.

(j)(2)(iii)(B) through (j)(2)(iv) [Reserved]. For guidance see §86.010-18.

(j)(3) *Verification of in-use monitoring performance ratios*.

(j)(3)(i) through (j)(3)(iii) [Reserved]. For guidance see §86.010-18.

(j)(3)(iv) For each monitoring performance group, the data must include all of the in-use performance tracking data reported through SAE J1979/J1939 (i.e., all numerators, denominators, the general denominator, and the ignition cycle counter), the date the data were collected, the odometer reading, the VIN, and the calibration ID.

(j)(3)(v) and (j)(3)(vi) [Reserved]. For guidance see §86.010-18.

(k) Standardization requirements

(k) *Standardization requirements*.

(k)(1) through (k)(1)(i)(B) [Reserved]. For guidance see §86.010-18.

(k)(1)(i)(C) SAE J1962 "Diagnostic Connector – Equivalent to ISO/DIS 15031-3: December 14, 2001," April 2002.

(k)(1)(i)(D) through (k)(1)(ii)(A) [Reserved]. For guidance see §86.010-18.

(k)(2) *Diagnostic connector*. A standard data link connector conforming to SAE J1962 or SAE J1939-13 specifications (except as provided for in paragraph (k)(2)(iii) of this section) must be included in each vehicle.

(k)(2)(i) The connector must be located in the driver's side foot-well region of the vehicle interior in the area bound by the driver's side of the vehicle and the driver's side edge of the center console (or the vehicle centerline if the vehicle does not have a center console) and at a location no higher than the bottom of the steering wheel when in the lowest adjustable position. The connector shall not be located on or in the center console (i.e., neither on the horizontal faces near the floor-mounted gear selector, parking brake lever, or cup-holders nor on the vertical faces near the car stereo, climate system, or navigation system controls). The location of the

connector shall be capable of being easily identified and accessed (e.g., to connect an off-board tool). For vehicles equipped with a driver's side door, the connector must be identified and accessed easily by someone standing (or "crouched") on the ground outside the driver's side of the vehicle with the driver's side door open. The Administrator may approve an alternative location upon request from the manufacturer. In all cases, the installation position of the connector must be both identified and accessed easily by someone standing outside the vehicle and protected from accidental damage during normal vehicle use.

(k)(2)(ii) If the connector is covered, the cover must be removable by hand without the use of any tools and be labeled "OBD" to aid technicians in identifying the location of the connector. Access to the diagnostic connector shall not require opening or the removal of any storage accessory (e.g., ashtray, coinbox). The label must clearly identify that the connector is located behind the cover and is consistent with language and/or symbols commonly used in the automobile and/or heavy truck industry.

(k)(2)(iii) If the ISO 15765-4 communication protocol is used for the required OBD standardized functions, the connector must meet the "Type A" specifications of SAE J1962. Any pins in the connector that provide electrical power must be properly fused to protect the integrity and usefulness of the connector for diagnostic purposes and shall not exceed 20.0 Volts DC regardless of the nominal vehicle system or battery voltage (e.g., 12V, 24V, 42V).

(k)(2)(iv) If the SAE J1939 protocol is used for the required OBD standardized functions, the connector must meet the specifications of SAE J1939-13. Any pins in the connector that provide electrical power must be properly fused to protect the integrity and usefulness of the connector for diagnostic purposes.

(k)(2)(v) The manufacturer may equip engines/vehicles with additional diagnostic connectors for manufacturer-specific purposes (i.e., purposes other than the required OBD functions). However, if the additional connector conforms to the "Type A" specifications of SAE J1962 or the specifications of SAE J1939-13 and is located in the vehicle interior near the required connector as described in this paragraph (k)(2) of this section, the connector(s) must be labeled clearly to identify which connector is used to access the standardized OBD information required by paragraph (k) of this section.

(k)(3) *Communications to a scan tool*. All OBD control modules (e.g., engine, auxiliary emission control module) on a single vehicle must use the same protocol for communication of required emission-related messages from on-board to off-board network communications to a scan tool meeting SAE J1978 specifications or designed to communicate with an SAE J1939 network. Engine manufacturers shall not alter normal operation of the engine emission control system due to the presence of off-board test equipment accessing information required by this paragraph (k). The OBD system must use one of the following standardized protocols:

(k)(3)(i) ISO 15765-4. All required emission-related messages using this protocol must use a 500 kbps baud rate.

(k)(3)(ii) SAE J1939. This protocol may only be used on vehicles with diesel engines.

(k)(4) *Required emission related functions*. The following standardized functions must be implemented in accordance with the specifications in SAE J1979 or SAE J1939 to allow for access to the required information by a scan tool meeting SAE J1978 specifications or designed to communicate with an SAE J1939 network:

(k)(4)(i) *Ready status*. In accordance with SAE J1979/J1939-73 specifications, the OBD system must indicate "complete" or "not complete" for each of the installed monitored components and systems identified in paragraphs (g) and (i)(3) of this section, and paragraph (h) with the exception of §86.010-18(h)(4). All components or systems identified in §86.010-18(h)(1) or (h)(2), or (i)(3) of this section that are monitored continuously must always indicate "complete." Components or systems that are not subject to being monitored continuously must immediately indicate "complete" upon the respective monitor(s) being executed fully and determining that the component or system is not malfunctioning. A component or system must also indicate "complete" if, after the requisite number of decisions necessary for determining MIL status has been executed fully, the monitor indicates a malfunction of the component or system. The status for each of the monitored components or systems must indicate "not complete" whenever diagnostic memory has been cleared or erased by a means other than that allowed in paragraph

(b) of this section. Normal vehicle shut down (i.e., key-off/engine-off) shall not cause the status to indicate "not complete."

(k)(4)(i)(A) [Reserved]. For guidance see §86.010-18.

(k)(4)(i)(B) For the evaporative system monitor, the ready status must be set in accordance with this paragraph (k)(4)(i) when both the functional check of the purge valve and, if applicable, the leak detection monitor of the hole size specified in §86.010-18(h)(7)(ii)(B) indicate that they are complete.

(k)(4)(i)(C) If the manufacturer elects to indicate ready status through the MIL in the key-on/engine-off position as provided for in §86.010-18(b)(1)(iii), the ready status must be indicated in the following manner: If the ready status for all monitored components or systems is "complete," the MIL shall remain continuously activated in the key-on/engine-off position for at least 10-20 seconds. If the ready status for one or more of the monitored components or systems is "not complete," after at least 5 seconds of operation in the key-on/engine-off position with the MIL activated continuously, the MIL shall blink once per second for 5-10 seconds. The data stream value for MIL status as required in paragraph (k)(4)(ii) of this section must indicate "commanded off" during this sequence unless the MIL has also been "commanded on" for a detected malfunction.

(k)(4)(ii) *Data stream*. The following signals must be made available on demand through the standardized data link connector in accordance with SAE J1979/J1939 specifications. The actual signal value must always be used instead of a limp home value.

(k)(4)(ii)(A) through (k)(4)(ii)(C) [Reserved]. For guidance see §86.010-18.

(k)(4)(iii) *Freeze frame*.

(k)(4)(iii)(A) "Freeze frame" information required to be stored pursuant to §86.010-18(b)(2)(iv), (h)(1)(iv)(D), and (h)(2)(vi) must be made available on demand through the standardized data link connector in accordance with SAE J1979/J1939-73 specifications.

(k)(4)(iii)(B) [Reserved]. For guidance see §86.010-18.

(k)(4)(iii)(C) Only one frame of data is required to be recorded. The manufacturer may choose to store additional frames provided that at least the required frame can be read by a scan tool meeting SAE J1978 specifications or designed to communicate with an SAE J1939 network.

(k)(4)(iv) *Diagnostic trouble codes*.

(k)(4)(iv)(A) For all monitored components and systems, any stored pending, MIL-on, and previous-MIL-on DTCs must be made available through the diagnostic connector in a standardized format in accordance with SAE J1939 or ISO 15765-4 specifications. Standardized DTCs conforming to the applicable standardized specifications must be employed.

(k)(4)(iv)(B) and (k)(4)(iv)(C) [Reserved]. For guidance see §86.010-18.

(k)(4)(iv)(D) A pending or MIL-on DTC (as required in paragraphs (g) and (i) of this section and §86.010-18(h)) must be stored and available to an SAE J1978 or SAE J1939 scan tool within 10 seconds after a monitor has determined that a malfunction or potential malfunction has occurred. A permanent DTC must be stored and available to an SAE J1978 or SAE J1939 scan tool no later than the end of an ignition cycle in which the corresponding MIL-on DTC that caused MIL activation has been stored.

(k)(4)(iv)(E) Pending DTCs for all components and systems (including those monitored continuously and non-continuously) must be made available through the diagnostic connector in accordance with the applicable standard's specifications. A manufacturer using alternative statistical protocols for MIL activation as allowed in §86.010-18(b)(2)(iii) must submit the details of their protocol for setting pending DTCs. The protocol must be, overall, equivalent to the requirements of this paragraph (k)(4)(iv)(E) and provide service technicians with a quick and accurate indication of a potential malfunction.

(k)(4)(iv)(F) Permanent DTC for all components and systems must be made available through the diagnostic connector in a standardized format that distinguishes permanent DTCs from pending DTCs, MIL-on DTCs, and previous-MIL-on DTCs. A MIL-on DTC must be stored as a permanent DTC no later than the end of the ignition cycle and subsequently at all times that the MIL-on DTC is commanding the MIL on. Permanent DTCs must be stored in non-volatile random access memory (NVRAM) and shall not be erasable by any scan tool command or by disconnecting power to the on-board computer. Permanent DTCs must be erasable if the engine control module is reprogrammed and the ready status described in paragraph (k)(4)(i) of this

section for all monitored components and systems are set to “not complete.” The OBD system must have the ability to store a minimum of four current MIL-on DTCs as permanent DTCs in NVRAM. If the number of MIL-on DTCs currently commanding activation of the MIL exceeds the maximum number of permanent DTCs that can be stored, the OBD system must store the earliest detected MIL-on DTC as permanent DTC. If additional MIL-on DTCs are stored when the maximum number of permanent DTCs is already stored in NVRAM, the OBD system shall not replace any existing permanent DTC with the additional MIL-on DTCs.

(k)(4)(v) *Test results*.

(k)(4)(v)(A) Except as provided for in §86.010-18(k)(4)(v)(G), for all monitored components and systems identified in paragraph (g) of this section and §86.010-18(h), results of the most recent monitoring of the components and systems and the test limits established for monitoring the respective components and systems must be stored and available through the data link in accordance with the standardized format specified in SAE J1979 (for engines using the ISO 15765-4 protocol) or SAE J1939.

(k)(4)(v)(B) [Reserved]. For guidance see §86.010-18.

(k)(4)(v)(C) The test results must be standardized such that the name of the monitored component (e.g., catalyst bank 1) can be identified by a generic scan tool and the test results and limits can be scaled and reported by a generic scan tool with the appropriate engineering units.

(k)(4)(v)(D) through (k)(4)(v)(G) [Reserved]. For guidance see §86.010-18.

(k)(4)(vi) *Software calibration identification (CAL ID)*. On all engines, a single software calibration identification number (CAL ID) for each monitor or emission critical control unit(s) must be made available through the standardized data link connector in accordance with the SAE J1979/J1939 specifications. A unique CAL ID must be used for every emission-related calibration and/or software set having at least one bit of different data from any other emission-related calibration and/or software set. Control units coded with multiple emission or diagnostic calibrations and/or software sets must indicate a unique CAL ID for each variant in a manner that enables an off-board device to determine which variant is being used by the vehicle. Control units that use a strategy that will result in MIL activation if the incorrect variant is used (e.g., control units that contain variants for manual and automatic transmissions but will activate the MIL if the selected variant does not match the type of transmission mated to the engine) are not required to use unique CAL IDs.

(k)(4)(vii) *Software calibration verification number (CVN)*.

(k)(4)(vii)(A) All engines must use an algorithm to calculate a single calibration verification number (CVN) that verifies the on-board computer software integrity for each monitor or emission critical control unit that is electronically reprogrammable. The CVN must be made available through the standardized data link connector in accordance with the SAE J1979/J1939 specifications. The CVN must indicate whether the emission-related software and/or calibration data are valid and applicable for the given vehicle and CAL ID.

(k)(4)(vii)(B) [Reserved]. For guidance see §86.010-18.

(k)(4)(vii)(C) The CVN must be calculated at least once per drive cycle and stored until the CVN is subsequently updated. Except for immediately after a reprogramming event or a non-volatile memory clear or for the first 30 seconds of engine operation after a volatile memory clear or battery disconnect, the stored value must be made available through the data link connector to a generic scan tool in accordance with SAE J1979/J1939 specifications. The stored CVN value shall not be erased when DTC memory is erased by a generic scan tool in accordance with SAE J1979/J1939 specifications or during normal vehicle shut down (i.e., key-off/engine-off).

(k)(4)(vii)(D) The CVN and CAL ID combination information must be available for all engines/vehicles in a standardized electronic format that allows for off-board verification that the CVN is valid and appropriate for a specific vehicle and CAL ID.

(k)(4)(viii) *Vehicle identification number (VIN)*.

(k)(4)(viii)(A) All vehicles must have the vehicle identification number (VIN) available in a standardized format through the standardized data link connector in accordance with SAE J1979/J1939 specifications. Only one electronic control unit per vehicle may report the VIN to an SAE J1978/J1939 scan tool.

(k)(4)(viii)(B) [Reserved]. For guidance see §86.010-18.

(k)(4)(ix) *Erasure of diagnostic information*.

(k)(4)(ix)(A) For purposes of this paragraph (k)(4)(ix), “emission-related diagnostic information” includes all of the following: ready status as required by paragraph (k)(4)(i) of this section; data stream information as required by paragraph (k)(4)(ii) of this section including the number of stored MIL-on DTCs, distance traveled while MIL activated, number of warm-up cycles since DTC memory last erased, and distance traveled since DTC memory last erased; freeze frame information as required by paragraph (k)(4)(iii) of this section; pending, MIL-on, and previous-MIL-on DTCs as required by paragraph (k)(4)(iv) of this section; and, test results as required by paragraph (k)(4)(v) of this section.

(k)(4)(ix)(B) [Reserved]. For guidance see §86.010-18.

(k)(5) *In-use performance ratio tracking requirements*.

(k)(5)(i) For each monitor required in paragraphs (g) and (i) of this section and §86.010-18(h) to separately report an in-use performance ratio, manufacturers must implement software algorithms to report a numerator and denominator in the standardized format specified in this paragraph (k)(5) in accordance with the SAE J1979/J1939 specifications.

(k)(5)(ii) For the numerator, denominator, general denominator, and ignition cycle counters required by §86.010-18(e), the following numerical value specifications apply:

(k)(5)(ii)(A) Each number shall have a minimum value of zero and a maximum value of 65,535 with a resolution of one.

(k)(5)(ii)(B) Each number shall be reset to zero only when a non-volatile random access memory (NVRAM) reset occurs (e.g., reprogramming event) or, if the numbers are stored in keep-alive memory (KAM), when KAM is lost due to an interruption in electrical power to the control unit (e.g., battery disconnect). Numbers shall not be reset to zero under any other circumstances including when a scan tool command to clear DTCs or reset KAM is received.

(k)(5)(ii)(C) To avoid overflow problems, if either the numerator or denominator for a specific component reaches the maximum value of 65,535 ±2, both numbers shall be divided by two before either is incremented again.

(k)(5)(ii)(D) To avoid overflow problems, if the ignition cycle counter reaches the maximum value of 65,535 ±2, the ignition cycle counter shall rollover and increment to zero on the next ignition cycle.

(k)(5)(ii)(E) To avoid overflow problems, if the general denominator reaches the maximum value of 65,535 ±2, the general denominator shall rollover and increment to zero on the next drive cycle that meets the general denominator definition.

(k)(5)(ii)(F) If a vehicle is not equipped with a component (e.g., oxygen sensor bank 2, secondary air system), the corresponding numerator and denominator for that specific component shall always be reported as zero.

(k)(5)(iii) For the ratio required by §86.010-18(e), the following numerical value specifications apply:

(k)(5)(iii)(A) The ratio shall have a minimum value of zero and a maximum value of 7.99527 with a resolution of 0.000122.

(k)(5)(iii)(B) The ratio for a specific component shall be considered to be zero whenever the corresponding numerator is equal to zero and the corresponding denominator is not zero.

(k)(5)(iii)(C) The ratio for a specific component shall be considered to be the maximum value of 7.99527 if the corresponding denominator is zero or if the actual value of the numerator divided by the denominator exceeds the maximum value of 7.99527.

(k)(6) *Engine run time tracking requirements*.

(k)(6)(i) For all gasoline and diesel engines, the manufacturer must implement software algorithms to track and report individually in a standardized format the amount of time the engine has been operated in the following conditions:

(k)(6)(i)(A) Total engine run time.

(k)(6)(i)(B) Total idle run time (with “idle” defined as accelerator pedal released by the driver, vehicle speed less than or equal to one mile per hour, engine speed greater than or equal to 50 to 150 rpm below the normal, warmed-up idle speed (as determined in the drive position for vehicles equipped with an automatic transmission), and power take-off not active).

(k)(6)(i)(C) Total run time with power take off active.

(k))(6)(ii) For each counter specified in paragraph (k)(6)(i) of this section, the following numerical value specifications apply:

(k)(6)(ii)(A) Each number shall be a four-byte value with a minimum value of zero, a resolution of one second per bit, and an accuracy of +/- ten seconds per drive cycle.

(k)(6)(ii)(B) Each number shall be reset to zero only when a non-volatile memory reset occurs (e.g., reprogramming event). Numbers shall not be reset to zero under any other circumstances including when a scan tool (generic or enhanced) command to clear fault codes or reset KAM is received.

(k)(6)(ii)(C) To avoid overflow problems, if any of the individual counters reach the maximum value, all counters shall be divided by two before any are incremented again.

(k)(6)(ii)(D) The counters shall be made available to a generic scan tool in accordance with the SAE J1979/J1939 specifications and may be rescaled when transmitted, if required by the SAE specifications, from a resolution of one second per bit to no more than three minutes per bit.

(l) Monitoring system demonstration requirements for certification

(l) *Monitoring system demonstration requirements for certification*.

(l)(1) *General*.

(l)(1)(i) through (l)(1)(iii) [Reserved]. For guidance see §86.010-18.

(l)(2) *Selection of test engines*.

(l)(2)(i) [Reserved]. For guidance see §86.010-18.

(l)(2)(ii) A manufacturer certifying one to five engine families in a given model year must provide emissions test data for a single test engine from one engine rating. A manufacturer certifying six to ten engine families in a given model year must provide emissions test data for a single test engine from two different engine ratings. A manufacturer certifying eleven or more engine families in a given model year must provide emissions test data for a single test engine from three different engine ratings. A manufacturer may forego submittal of test data for one or more of these test engines if data have been submitted previously for all of the engine ratings and/or if all requirements for certification carry-over from one model year to the next are satisfied.

(l)(2)(iii) For a given model year, a manufacturer may elect to provide emissions data for test engines from more engine ratings than required by paragraph (l)(2)(ii) of this section. For each additional engine rating tested in that given model year, the number of engine ratings required for testing in one future model year will be reduced by one.

(l)(2)(iv) For the test engine, the manufacturer must use an engine aged for a minimum of 125 hours fitted with exhaust aftertreatment emission controls aged to be representative of useful life aging. The manufacturer is required to submit a description of the accelerated aging process and/or supporting data. The process and/or data must demonstrate assurance that deterioration of the exhaust aftertreatment emission controls is stabilized sufficiently such that it represents emission control performance at the end of the useful life.

(l)(3) *Required testing*. Except as otherwise described in this paragraph (l)(3) of this section, the manufacturer must perform single malfunction testing based on the applicable test with the components/systems set at their malfunction criteria limits as determined by the manufacturer for meeting the emissions thresholds required in paragraphs (g) and (i) of this section and §86.010-18(h).

(l)(3)(i) *Required testing for diesel-fueled/compression ignition engines*.

(l)(3)(i)(A) [Reserved]. For guidance see §86.010-18.

(l)(3)(i)(B) *Engine misfire*. The manufacturer must perform a test at the malfunction limit established by the manufacturer for the monitoring required by paragraph (g)(2)(ii)(B) of this section.

(l)(3)(i)(C) through (l)(3)(i)(K) [Reserved]. For guidance see §86.010-18.

(l)(3)(ii) *Required testing for gasoline-fueled/spark-ignition engines*.

(l)(3)(ii)(A) through (l)(3)(ii)(I) [Reserved]. For guidance see §86.010-18.

(l)(3)(iii) *Required testing for all engines*.

(l)(3)(iii)(A) and (l)(3)(iii)(B) [Reserved]. For guidance see §86.010-18.

(l)(3)(iv) [Reserved]. For guidance see §86.010-18.

(l)(4) *Testing protocol*.

(l)(4)(i) [Reserved]. For guidance see §86.010-18.

(l)(4)(ii) *Test sequence*.

(l)(4)(ii)(A) through (l)(4)(ii)(C) [Reserved]. For guidance see §86.010-18.

(l)(4)(iii) A manufacturer required to test more than one test engine according to paragraph (l)(2)(ii) of this section may use internal calibration sign-off test procedures (e.g., forced cool downs, less frequently calibrated emission analyzers) instead of official test procedures to obtain the emission test data required by this paragraph (l) of this section for all but one of the required test engines. The manufacturer may elect this option if the data from the alternative test procedure are representative of official emissions test results. A manufacturer using this option is still responsible for meeting the malfunction criteria specified in paragraphs (g) and (i) of this section and §86.010-18(h) if and when emissions tests are performed in accordance with official test procedures.

(l)(4)(iv) [Reserved]. For guidance see §86.010-18.

(l)(5) *Evaluation protocol*.

(l)(5)(i) [Reserved]. For guidance see §86.010-18.

(l)(5)(ii) If the MIL activates prior to emissions exceeding the applicable malfunction criteria limits specified in paragraphs (g) and (i) of this section and §86.010-18(h), no further demonstration is required. With respect to the misfire monitor demonstration test, if the manufacturer has elected to use the minimum misfire malfunction criteria of one percent as allowed in paragraphs (g)(2)(ii)(B) of this section and §86.010-18(h)(2)(ii)(B), no further demonstration is required provided the MIL activates with engine misfire occurring at the malfunction criteria limit.

(l)(5)(iii) through (l)(5)(iv) [Reserved]. For guidance see §86.010-18.

(l)(6) *Confirmatory testing*.

(l)(6)(i) The Administrator may perform confirmatory testing to verify the emission test data submitted by the manufacturer as required by paragraph (l) of this section comply with its requirements and the malfunction criteria set forth in paragraphs (g) and (i) of this section and §86.010-18(h). Such confirmatory testing is limited to the test engine(s) required by paragraph (l)(2) of this section.

(l)(6)(ii) through (l)(7) [Reserved]. For guidance see §86.010-18.

(m) Certification documentation

(m) *Certification documentation requirements*.

(m)(1) through (m)(2)(iv) [Reserved]. For guidance see §86.010-18.

(m)(2)(v) Emissions test data, a description of the testing sequence (e.g., the number and types of preconditioning cycles), approximate time (in seconds) of MIL activation during the test, diagnostic trouble code(s) and freeze frame information stored at the time of detection, corresponding test results (e.g. SAE J1979 Mode/Service $06, SAE J1939 Diagnostic Message 8 (DM8)) stored during the test, and a description of the modified or deteriorated components used for malfunction simulation with respect to the demonstration tests specified in paragraph (l) of this section. The freeze frame data are not required for engines subject to paragraph (o)(3) of this section.

(m)(2)(vi) through (m)(2)(x) [Reserved]. For guidance see §86.010-18.

(m)(2)(xi) A written identification of the communication protocol utilized by each engine for communication with a SAE J1978/J1939 scan tool.

(m)(2)(xii) A pictorial representation or written description of the diagnostic connector location including any covers or labels.

(m)(2)(xiii) [Reserved]. For guidance see §86.010-18.

(m)(2)(xiv) Build specifications provided to engine purchasers or chassis manufacturers detailing all specifications or limitations imposed on the engine purchaser relevant to OBD requirements or emissions compliance (e.g., allowable MIL locations, connector location specifications, cooling system heat rejection rates). A description of the method or copies of agreements used to ensure engine purchasers or chassis manufacturers will comply with the OBD and emissions relevant build specifications (e.g., signed agreements, required audit/evaluation procedures).

(m)(2)(xv) [Reserved]. For guidance see §86.010-18.

(n) Deficiencies

(n) [Reserved]. For guidance see §86.010-18.

(o) Implementation schedule

(o) *Implementation schedule*. Except as provided for in paragraph (o)(4) of this section, the requirements of this section must be met according to the following provisions:

(o)(1) *OBD groups*. The manufacturer shall define one or more OBD groups to cover all engine ratings in all engine families. The manufacturer must submit a grouping plan for Administrator review and approval detailing the OBD groups and the engine families and engine ratings within each group for a given model year.

(o)(2) *Full OBD*.

(o)2)(i) For all engine ratings subject to §86.010-18, the manufacturer must implement an OBD system meeting the requirements of this section.

(o)(2)(ii) On one engine rating within each of the manufacturer's OBD groups, the manufacturer must implement an OBD system meeting the requirements of this section. These "full OBD" ratings will be known as the "OBD parent" ratings. The OBD parent rating for each OBD group must be chosen as the rating having the highest weighted projected US sales within the OBD group, with US sales being weighted by the useful life of the engine rating.

(o)(3) *Extrapolated OBD*. For all other engine ratings within each OBD group, the manufacturer must implement an OBD system meeting the requirements of this section except that the OBD system is not required to detect a malfunction prior to exceeding the emission thresholds shown in Table 1 of paragraph (g) of this section and Table 2 of §86.010-18(h). These extrapolated OBD engines will be know as the "OBD child" ratings. On these OBD child ratings, rather than detecting a malfunction prior to exceeding the emission thresholds, the manufacturer must submit a plan for Administrator review and approval that details the engineering evaluation the manufacturer will use to establish the malfunction criteria for the OBD child ratings. The plan must demonstrate both the use of good engineering judgment in establishing the malfunction criteria, and robust detection of malfunctions, including consideration of differences of base engine, calibration, emission control components, and emission control strategies.

(o)(4) Engines certified as alternative fueled engines shall meet the following requirements:

(o)(4)(i) To the extent feasible, those specified in paragraph (i)(3) of this section.

(o)(4)(ii) Monitor the NOx aftertreatment system on engines so equipped. A malfunction must be detected if:

(o)(4)(ii)(A) The NOx aftertreatment system has no detectable amount of NOx aftertreatment capability (i.e., NOx catalyst conversion or NOx adsorption).

(o)(4)(ii)(B) The NOx aftertreatment substrate is completely destroyed, removed, or missing.

(o)(4)(ii)(C) The NOx aftertreatment assembly is replaced with a straight pipe.

(p) In-use compliance standards

(p) *In-use compliance standards*. For monitors required to indicate a malfunction before emissions exceed a certain emission threshold (e.g., 2 times any of the applicable standards):

(p)(1) On the full OBD ratings as defined in paragraph (o)(2) of this section, separate in-use emissions thresholds shall apply. These thresholds are determined by doubling the applicable thresholds as shown in Table 1 of paragraph (g) of this section and Table 2 of §86.010-18(h). The resultant thresholds apply only in-use and do not apply for certification or selective enforcement auditing.

(p)(2) The extrapolated OBD ratings as defined in paragraph (o)(3) of this section shall not be evaluated against emissions levels for purposes of OBD compliance in-use.

(p)(3) Only the test cycle and standard determined and identified by the manufacturer at the time of certification in accordance with §86.010-18(f) as the most stringent shall be used for the purpose of determining OBD system noncompliance in-use.

(p)(4) For monitors subject to meeting the minimum in-use monitor performance ratio of 0.100 in paragraph (d)(1)(ii) of this section, the OBD system shall not be considered noncompliant unless a representative sample indicates the in-use ratio is below 0.050.

(p)(5) An OBD system shall not be considered noncompliant solely due to a failure or deterioration mode of a monitored component or system that could not have been reasonably foreseen to occur by the manufacturer.

§ 86.013-30 Certification.

Section 86.013–30 includes text that specifies requirements that differ from §86.010–30. Where a paragraph in §86.010–30 is identical and applicable to §86.013–30, this may be indicated by specifying the corresponding paragraph and the statement "[Reserved]. For guidance see §86.010–30."

(a) thru (e)

(a) introductory text through (f)(1)(i) [Reserved]. For guidance see §86.010-30.

(f) OBD certification

(f)(1)(ii) *Diesel*.

(f)(1)(ii)(A) If monitored for emissions performance—a reduction catalyst is replaced with a deteriorated or defective catalyst, or an electronic simulation of such, resulting in exhaust NOx emissions exceeding the applicable NOx FEL+0.3 g/bhp-hr. Also if monitored for emissions performance—an oxidation catalyst is replaced with a deteriorated or defective catalyst, or an electronic simulation of such, resulting in exhaust NMHC emissions exceeding 2 times the applicable NMHC standard.

(f)(1)(ii)(B) If monitored for performance—a particulate trap is replaced with a deteriorated or defective trap, or an electronic simulation of such, resulting in either exhaust PM emissions exceeding the applicable FEL+0.04 g/bhp-hr or 0.05 g/bhp-hr PM, whichever is higher; or, exhaust NMHC emissions exceeding 2 times the applicable NMHC standard. Also, if monitored for performance—a particulate trap is replaced with a catastrophically failed trap or a simulation of such.

(f)(2) [Reserved]. For guidance see §86.004-30.

(f)(3)(i) *Oxygen sensors and air-fuel ratio sensors downstream of aftertreatment devices.*

(f)(3)(i)(A) [Reserved]. For guidance see §86.007-30.

(f)(3)(i)(B) *Diesel*. If so equipped, any oxygen sensor or air-fuel ratio sensor located downstream of aftertreatment devices is replaced with a deteriorated or defective sensor, or an electronic simulation of such, resulting in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.04 g/bhp-hr or 0.05 g/bhp-hr PM, whichever is higher; or, the applicable NOx FEL+0.3 g/bhp-hr; or, 2 times the applicable NMHC standard.

(f)(3)(ii) *Oxygen sensors and air-fuel ratio sensors upstream of aftertreatment devices*.

(f)(3)(ii)(A) [Reserved]. For guidance see §86.007-30.

(f)(3)(ii)(B) *Diesel*. If so equipped, any oxygen sensor or air-fuel ratio sensor located upstream of aftertreatment devices is replaced with a deteriorated or defective sensor, or an electronic simulation of such, resulting in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.02 g/bhp-hr or 0.03 g/bhp-hr PM, whichever is higher; or, the applicable NOx FEL+0.3 g/bhp-hr; or, 2 times the applicable NMHC standard; or, 2 times the applicable CO standard.

(f)(3)(iii) *NOx sensors*.

(f)(3)(iii)(A) [Reserved]. For guidance see §86.007-30.

(f)(3)(iii)(B) *Diesel*. If so equipped, any NOx sensor is replaced with a deteriorated or defective sensor, or an electronic simulation of such, resulting in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.04 g/bhp-hr or 0.05 g/bhp-hr PM, whichever is higher; or, the applicable NOx FEL+0.3 g/bhp-hr.

(f)(4) [Reserved]. For guidance see §86.010-30.

(f)(5)(i) [Reserved]. For guidance see §86.007-30.

(f)(5)(ii) *Diesel*. A malfunction condition is induced in any emission-related engine system or component, including but not necessarily limited to, the exhaust gas recirculation (EGR) system, if equipped, and the fuel control system, singularly resulting in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.02 g/bhp-hr or 0.03 g/bhp-hr PM, whichever is higher; or, the applicable NOx FEL+0.3 g/bhp-hr; or, 2 times the applicable NMHC standard; or, 2 times the applicable CO standard.

(f)(6) [Reserved]. For guidance see §86.010-30.

§ 86.016-18 On-board Diagnostics for engines used in applications greater than 14,000 pounds GVWR.

Section 86.016–18 includes text that specifies requirements that differ from §86.013–18. Where a paragraph in §86.013–18 is identical and applicable to §86.016–18, this may be indicated by specifying the corresponding paragraph and the statement "[Reserved]. For guidance see §86.013–18."

(a) thru (n)

(a) through (n) [Reserved]. For guidance see §86.013-18.

(o) Implementation schedule

(o) *Implementation schedule*. Except as provided for in paragraph (o)(3) of this section, the requirements of this section must be met according to the following provisions:

(o)(1) *OBD groups*. The manufacturer shall define one or more OBD groups to cover all engine ratings in all engine families. The manufacturer must submit a grouping plan for Administrator review and approval detailing the OBD groups and the engine families and engine ratings within each group for a given model year.

(o)(2) *Full OBD*. The manufacturer must implement an OBD system meeting the requirements of this section on all engine ratings in all engine families.

(o)(3) Engines certified as alternative fueled engines shall meet the following requirements:

(o)(3)(i) To the extent feasible, those specified in §86.013-18(i)(3).

(o)(3)(ii) Monitor the NOx aftertreatment system on engines so equipped. A malfunction must be detected if:

(o)(3)(ii)(A) The NOx aftertreatment system has no detectable amount of NOx aftertreatment capability (i.e., NOx catalyst conversion or NOx adsorption).

(o)(3)(ii)(B) The NOx aftertreatment substrate is completely destroyed, removed, or missing.

(o)(3)(ii)(C) The NOx aftertreatment assembly is replaced with a straight pipe.

(p) In-use compliance standards

(p) *In-use compliance standards*. For monitors required to indicate a malfunction before emissions exceed a certain emission threshold (e.g., 2 times any of the applicable standards):

(p)(1) On the engine ratings tested according to §86.013-18(l)(2)(ii), the certification emissions thresholds shall apply in-use.

(p)(2) On the manufacturer's remaining engine ratings, separate in-use emissions thresholds shall apply. These thresholds are determined by doubling the applicable thresholds as shown in Table 1 of §86.013-18(g) and Table 2 of §86.010-18(h). The resultant thresholds apply only in-use and do not apply for certification or selective enforcement auditing.

(p)(3) An OBD system shall not be considered noncompliant solely due to a failure or deterioration mode of a monitored component or system that could not have been reasonably foreseen to occur by the manufacturer.

§ 86.019-18 On-board Diagnostics for engines used in applications greater than 14,000 pounds GVWR.

Section 86.019–18 includes text that specifies requirements that differ from §§86.013–18 and 86.016-18. Where a paragraph in §86.013–18 is identical and applicable to §86.019–18, this may be indicated by specifying the corresponding paragraph and the statement "[Reserved]. For guidance see §86.013–18."

(a) through (k)(6) [Reserved]. For guidance see §86.013-18.

(k)(7) For 2019 and subsequent model year alternative-fueled engines derived from a diesel-cycle engine, a manufacturer may meet the standardization requirements of §86.013-18(k) that are applicable to diesel engines rather than the requirements applicable to gasoline engines.

(l) through (n) [Reserved]. For guidance see §86.013-18.

(o) *Implementation schedule*. The manufacturer must implement an OBD system meeting the requirements of this section on all engines.

(p) *In-use compliance*. An OBD system shall not be considered noncompliant solely due to a failure or deterioration mode of a monitored component or system that could not have been reasonably foreseen to occur by the manufacturer.

Proposed OBD Requirements in Subpart S

§ 86.1806-07 On-board diagnostics for vehicles less than or equal to 14,000 pounds GVWR.

Section 86.1806–07 includes text that specifies requirements that differ from §86.1806-05. Where a paragraph in §86.1806-05 is identical and applicable to §86.1806-07, this may be indicated by specifying the corresponding paragraph and the statement "[Reserved]. For guidance see §86.1806-05."

(a) through (h)

(a) through (a)(2) [Reserved]. For guidance see §86.1806-05.

(a)(3) An OBD system demonstrated to fully meet the requirements in §86.007–17 may be used to meet the requirements of this section, provided that such an OBD system also incorporates appropriate transmission diagnostics as may be required under this section, and provided that the Administrator finds that a manufacturer's decision to use the flexibility in this paragraph (a)(3) is based on good engineering judgement.

(b) through (h) [Reserved]. For guidance see §86.1806-05.

(i) Deficiencies

(i) *Deficiencies and alternative fueled vehicles*. Upon application by the manufacturer, the Administrator may accept an OBD system as compliant even though specific requirements are not fully met. Such compliances without meeting specific requirements, or deficiencies, will be granted only if compliance would be infeasible or unreasonable considering such factors as, but not limited to: technical feasibility of the given monitor and lead time and production cycles including phase-in or phase-out of vehicle designs and programmed upgrades of computers. Unmet requirements should not be carried over from the previous model year except where unreasonable hardware or software modifications would be necessary to correct the deficiency, and the manufacturer has demonstrated an acceptable level of effort toward compliance as determined by the Administrator. Furthermore, EPA will not accept any deficiency requests that include the complete lack of a major diagnostic monitor ("major" diagnostic monitors being those for exhaust aftertreatment devices, oxygen sensor, air-fuel ratio sensor, NOx sensor, engine misfire, evaporative leaks, and diesel EGR, if equipped), with the possible exception of the special provisions for alternative fueled engines. For alternative fueled vehicles (e.g. natural gas, liquefied petroleum gas, methanol, ethanol), manufacturers may request the Administrator to waive specific monitoring requirements of this section for which monitoring may not be reliable with respect to the use of the alternative fuel. At a minimum, alternative fuel engines must be equipped with an OBD system meeting OBD requirements to the extent feasible as approved by the Administrator.

(j) CARB OBDII compliance option

(j) *California OBDII compliance option*. For light-duty vehicles, light-duty trucks, and heavy-duty vehicles weighing 14,000 pounds GVWR or less, demonstration of compliance with California OBD II requirements (Title 13 California Code of Regulations §1968.2 (13 CCR 1968.2)), as modified and released on August 11, 2006, shall satisfy the requirements of this section, except that compliance with 13 CCR 1968.2(e)(4.2.2)(C), pertaining to 0.02 inch evaporative leak detection, and 13 CCR 1968.2(d)(1.4), pertaining to tampering protection, are not required to satisfy the requirements of this section. Also, the deficiency provisions of 13 CCR 1968.2(k) do not apply. The deficiency provisions of paragraph (i) of this section and the evaporative leak detection requirement of §86.1806-05(b)(4) apply to manufacturers selecting this paragraph for demonstrating compliance. In addition, demonstration of compliance with 13

CCR 1968.2(e)(15.2.1)(C), to the extent it applies to the verification of proper alignment between the camshaft and crankshaft, applies only to vehicles equipped with variable valve timing.

(k) thru (m)

(k) through (m) [Reserved]. For guidance see §86.1806-05.

(n) Diesel complete HD vehicles - requirements

(n) For diesel complete heavy-duty vehicles, in lieu of the malfunction descriptions of §86.1806-05(b), the malfunction descriptions of this paragraph (n) shall apply. The OBD system must detect and identify malfunctions in all monitored emission-related powertrain systems or components according to the following malfunction definitions as measured and calculated in accordance with test procedures set forth in subpart B of this part (chassis-based test procedures), excluding those test procedures defined as "Supplemental" test procedures in §86.004–2 and codified in §§86.158, 86.159, and 86.160.

(n)(1) *Catalysts and particulate traps*.

(n)(1)(i) If equipped, catalyst deterioration or malfunction before it results in exhaust emissions exceeding 3 times the applicable NOx standard. This requirement applies only to reduction catalysts; monitoring of oxidation catalysts is not required. This monitoring need not be done if the manufacturer can demonstrate that deterioration or malfunction of the system will not result in exceedance of the threshold.

(n)(1)(ii) If equipped with a particulate trap, catastrophic failure of the device must be detected. Any particulate trap whose complete failure results in exhaust emissions exceeding 1.5 times the applicable standard or FEL for NOx or PM must be monitored for such catastrophic failure. This monitoring need not be done if the manufacturer can demonstrate that a catastrophic failure of the system will not result in exceedance of the threshold.

(n)(2) *Engine misfire*. Lack of cylinder combustion must be detected.

(n)(3)(i) *Oxygen sensors and air-fuel ratio sensors downstream of aftertreatment devices*. If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding any of the following levels: 4 times the applicable PM standard; or, 3 times the applicable NOx standard; or, 2.5 times the applicable NMHC standard.

(n)(3)(ii) *Oxygen sensors and air-fuel ratio sensors upstream of aftertreatment devices*. If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding any of the following levels: 4 times the applicable PM standard; or, 3 times the applicable NOx standard; or, 2.5 times the applicable NMHC standard; or, 2.5 times the applicable CO standard.

(n)(3)(iii) *NOx sensors*. If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding any of the following levels: 5 times the applicable PM standard; or, 4 times the applicable NOx standard.

(n)(4) [Reserved.]

(n)(5) *Other emission control systems and components*. Any deterioration or malfunction occurring in an engine system or component directly intended to control emissions, including but not necessarily limited to, the exhaust gas recirculation (EGR) system, if equipped, and the fuel control system, singularly resulting in exhaust emissions exceeding any of the following levels: 4 times the applicable PM standard; or, 3 times the applicable NOx standard; or, 2.5 times the applicable NMHC standard; or, 2.5 times the applicable CO standard. A functional check, as described in paragraph (n)(6) of this section, may satisfy the requirements of this paragraph (n)(5) provided the manufacturer can demonstrate that a malfunction would not cause emissions to exceed the applicable levels. This demonstration is subject to Administrator approval. For engines equipped with crankcase ventilation (CV), monitoring of the CV system is not necessary provided the manufacturer can demonstrate to the Administrator's satisfaction that the CV system is unlikely to fail.

(n)(6) *Other emission-related powertrain components*. Any other deterioration or malfunction occurring in an electronic emission-related powertrain system or component not otherwise described in paragraphs (n)(1) through (n)(5) of this section that either provides input to or receives commands from the on-board computer and has a measurable impact on emissions; monitoring of components required by this paragraph (n)(6) must be satisfied by employing

electrical circuit continuity checks and rationality checks for computer input components (input values within manufacturer specified ranges based on other available operating parameters), and functionality checks for computer output components (proper functional response to computer commands) except that the Administrator may waive such a rationality or functionality check where the manufacturer has demonstrated infeasibility. Malfunctions are defined as a failure of the system or component to meet the electrical circuit continuity checks or the rationality or functionality checks.

(n)(7) *Performance of OBD functions*. Any sensor or other component deterioration or malfunction which renders that sensor or component incapable of performing its function as part of the OBD system must be detected and identified on engines so equipped.

(o) Diesel complete HD vehicles - certification

(o) For diesel complete heavy-duty vehicles, in lieu of the certification provisions of §86.1806-05(k), the certification provisions of this paragraph (o) shall apply. For test groups required to have an OBD system, certification will not be granted if, for any test vehicle approved by the Administrator in consultation with the manufacturer, the malfunction indicator light does not illuminate under any of the following circumstances, unless the manufacturer can demonstrate that any identified OBD problems discovered during the Administrator's evaluation will be corrected on production vehicles.

(o)(1)(i) If monitored for emissions performance—a catalyst is replaced with a deteriorated or defective catalyst, or an electronic simulation of such, resulting in exhaust emissions exceeding 3 times the applicable NOx standard. This requirement applies only to reduction catalysts.

(o)(1)(ii) If monitored for performance—a particulate trap is replaced with a trap that has catastrophically failed, or an electronic simulation of such.

(o)(2) An engine misfire condition is induced and is not detected.

(o)(3)(i) If so equipped, any oxygen sensor or air-fuel ratio sensor located downstream of aftertreatment devices is replaced with a deteriorated or defective sensor, or an electronic simulation of such, resulting in exhaust emissions exceeding any of the following levels: 4 times the applicable PM standard; or, 3 times the applicable NOx standard; or, 2.5 times the applicable NMHC standard.

(o)(3)(ii) If so equipped, any oxygen sensor or air-fuel ratio sensor located upstream of aftertreatment devices is replaced with a deteriorated or defective sensor, or an electronic simulation of such, resulting in exhaust emissions exceeding any of the following levels: 4 times the applicable PM standard; or, 3 times the applicable NOx standard; or, 2.5 times the applicable NMHC standard; or, 2.5 times the applicable CO standard.

(o)(3)(iii) If so equipped, any NOx sensor is replaced with a deteriorated or defective sensor, or an electronic simulation of such, resulting in exhaust emissions exceeding any of the following levels: 5 times the applicable PM standard; or, 4 times the applicable NOx standard.

(o)(4) [Reserved.]

(o)(5) A malfunction condition is induced in any emission-related engine system or component, including but not necessarily limited to, the exhaust gas recirculation (EGR) system, if equipped, and the fuel control system, singularly resulting in exhaust emissions exceeding any of the following levels: 4 times the applicable PM standard; or, 3 times the applicable NOx standard; or, 2.5 times the applicable NMHC standard; or, 2.5 times the applicable CO standard.

(o)(6) A malfunction condition is induced in an electronic emission-related powertrain system or component not otherwise described in this paragraph (o) that either provides input to or receives commands from the on-board computer resulting in a measurable impact on emissions.

§ 86.1806-10 On-board diagnostics for vehicles less than or equal to 14,000 pounds GVWR.

Section 86.1806–10 includes text that specifies requirements that differ from §86.1806-05 and §86.1806-07. Where a paragraph in §86.1806-05 or §86.1806-07 is identical and applicable to

§86.1806-10, this may be indicated by specifying the corresponding paragraph and the statement "[Reserved]. For guidance see §86.1806-05." or "[Reserved]. For guidance see §86.1806-07."

(a) General

(a) *General*.

(a)(1) All light-duty vehicles, light-duty trucks and complete heavy-duty vehicles weighing 14,000 pounds GVWR or less (including MDPVs) must be equipped with an onboard diagnostic (OBD) system capable of monitoring all emission-related powertrain systems or components during the applicable useful life of the vehicle. All systems and components required to be monitored by these regulations must be evaluated periodically, but no less frequently than once per applicable certification test cycle as defined in paragraphs (a) and (d) of Appendix I of this part, or similar trip as approved by the Administrator.

(a)(2) [Reserved.]

(a)(3) An OBD system demonstrated to fully meet the requirements in §86.010–17 may be used to meet the requirements of this section, provided that such an OBD system also incorporates appropriate transmission diagnostics as may be required under this section, and provided that the Administrator finds that a manufacturer's decision to use the flexibility in this paragraph (a)(3) is based on good engineering judgement.

(b) thru (m)

(b) through (m) [Reserved]. For guidance see §86.1806-07.

(n) Diesel complete HD vehicles – requirements

(n) For diesel complete heavy-duty vehicles, in lieu of the malfunction descriptions of §86.1806-05(b), the malfunction descriptions of this paragraph (n) shall apply. The OBD system must detect and identify malfunctions in all monitored emission-related powertrain systems or components according to the following malfunction definitions as measured and calculated in accordance with test procedures set forth in subpart B of this part (chassis-based test procedures), excluding those test procedures defined as "Supplemental" test procedures in §86.004–2 and codified in §§86.158, 86.159, and 86.160.

(n)(1) *Catalysts and particulate traps*.

(n)(1)(i) If equipped, reduction catalyst deterioration or malfunction before it results in exhaust NOx emissions exceeding the applicable NOx standard+0.3 g/mi. If equipped, oxidation catalyst deterioration or malfunction before it results in exhaust NMHC emissions exceeding 2.5 times the applicable NMHC standard. These catalyst monitoring requirements need not be done if the manufacturer can demonstrate that deterioration or malfunction of the system will not result in exceedance of the threshold.

(n)(1)(ii) If equipped, diesel particulate trap deterioration or malfunction before it results in exhaust emissions exceeding any of the following levels: 4 times the applicable PM standard; or, exhaust NMHC emissions exceeding 2.5 times the applicable NMHC standard. Catastrophic failure of the particulate trap must also be detected. In addition, the absence of the particulate trap or the trapping substrate must be detected.

(n)(2) *Engine misfire*. Lack of cylinder combustion must be detected.

(n)(3)(i) *Oxygen sensors and air-fuel ratio sensors downstream of aftertreatment devices*. If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding any of the following levels: 4 times the applicable PM standard; or, the applicable NOx standard+0.3 g/mi; or, 2.5 times the applicable NMHC standard.

(n)(3)(ii) *Oxygen sensors and air-fuel ratio sensors upstream of aftertreatment devices*. If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding any of the following levels: the applicable PM standard+0.02 g/mi; or, the applicable NOx standard+0.3 g/mi; or, 2.5 times the applicable NMHC standard; or, 2.5 times the applicable CO standard.

(n)(3)(iii) *NOx sensors*. If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding any of the following levels: 4 times the applicable PM standard; or, the applicable NOx standard+0.3 g/mi.

(n)(4) [Reserved.]

(n)(5) *Other emission control systems and components*. Any deterioration or malfunction occurring in an engine system or component directly intended to control emissions, including but not necessarily limited to, the exhaust gas recirculation (EGR) system, if equipped, and the fuel control system, singularly resulting in exhaust emissions exceeding any of the following levels: 4 times the applicable PM standard; or, the applicable NOx standard+0.3 g/mi; or, 2.5 times the applicable NMHC standard; or, 2.5 times the applicable CO standard. A functional check, as described in paragraph (n)(6) of this section, may satisfy the requirements of this paragraph (n)(5) provided the manufacturer can demonstrate that a malfunction would not cause emissions to exceed the applicable levels. This demonstration is subject to Administrator approval. For engines equipped with crankcase ventilation (CV), monitoring of the CV system is not necessary provided the manufacturer can demonstrate to the Administrator's satisfaction that the CV system is unlikely to fail.

(n)(6) *Other emission-related powertrain components*. Any other deterioration or malfunction occurring in an electronic emission-related powertrain system or component not otherwise described in paragraphs (n)(1) through (n)(5) of this section that either provides input to or receives commands from the on-board computer and has a measurable impact on emissions; monitoring of components required by this paragraph (n)(6) must be satisfied by employing electrical circuit continuity checks and rationality checks for computer input components (input values within manufacturer specified ranges based on other available operating parameters), and functionality checks for computer output components (proper functional response to computer commands) except that the Administrator may waive such a rationality or functionality check where the manufacturer has demonstrated infeasibility. Malfunctions are defined as a failure of the system or component to meet the electrical circuit continuity checks or the rationality or functionality checks.

(n)(7) *Performance of OBD functions*. Any sensor or other component deterioration or malfunction which renders that sensor or component incapable of performing its function as part of the OBD system must be detected and identified on engines so equipped.

(o) Diesel complete HD vehicles – certification

(o) For diesel complete heavy-duty vehicles, in lieu of the certification provisions of §86.1806-05(k), the certification provisions of this paragraph (o) shall apply. For test groups required to have an OBD system, certification will not be granted if, for any test vehicle approved by the Administrator in consultation with the manufacturer, the malfunction indicator light does not illuminate under any of the following circumstances, unless the manufacturer can demonstrate that any identified OBD problems discovered during the Administrator's evaluation will be corrected on production vehicles.

(o)(1)(i) If monitored for emissions performance—a reduction catalyst is replaced with a deteriorated or defective catalyst, or an electronic simulation of such, resulting in exhaust NOx emissions exceeding the applicable NOx standard+0.3 g/mi. Also if monitored for emissions performance—an oxidation catalyst is replaced with a deteriorated or defective catalyst, or an electronic simulation of such, resulting in exhaust NMHC emissions exceeding 2.5 times the applicable NMHC standard.

(o)(1)(ii) If monitored for performance—a particulate trap is replaced with a deteriorated or defective trap, or an electronic simulation of such, resulting in exhaust PM emissions exceeding 4 times the applicable PM standard or exhaust NMHC emissions exceeding 2.5 times the applicable NMHC standard. Also, if monitored for performance—a particulate trap is replaced with a catastrophically failed trap or a simulation of such.

(o)(2) An engine misfire condition is induced and is not detected.

(o)(3)(i) If so equipped, any oxygen sensor or air-fuel ratio sensor located downstream of aftertreatment devices is replaced with a deteriorated or defective sensor, or an electronic simulation of such, resulting in exhaust emissions exceeding any of the following levels: 4 times the applicable PM standard; or, the applicable NOx standard+0.3 g/mi; or, 2.5 times the applicable NMHC standard.

(o)(3)(ii) If so equipped, any oxygen sensor or air-fuel ratio sensor located upstream of aftertreatment devices is replaced with a deteriorated or defective sensor, or an electronic

simulation of such, resulting in exhaust emissions exceeding any of the following levels: the applicable PM standard+0.02 g/mi; or, the applicable NOx standard+0.3 g/mi; or, 2.5 times the applicable NMHC standard; or, 2.5 times the applicable CO standard.

(o)(3)(iii) If so equipped, any NOx sensor is replaced with a deteriorated or defective sensor, or an electronic simulation of such, resulting in exhaust emissions exceeding any of the following levels: 4 times the applicable PM standard; or, the applicable NOx standard+0.3 g/mi.

(o)(4) [Reserved.]

(o)(5) A malfunction condition is induced in any emission-related engine system or component, including but not necessarily limited to, the exhaust gas recirculation (EGR) system, if equipped, and the fuel control system, singularly resulting in exhaust emissions exceeding any of the following levels: 4 times the applicable PM standard; or, the applicable NOx standard+0.3 g/mi; or, 2.5 times the applicable NMHC standard; or, 2.5 times the applicable CO standard.

(o)(6) A malfunction condition is induced in an electronic emission-related powertrain system or component not otherwise described in this paragraph (o) that either provides input to or receives commands from the on-board computer resulting in a measurable impact on emissions.

§ 86.1806-13 On-board diagnostics for vehicles less than or equal to 14,000 pounds GVWR.

Section 86.1806–13 includes text that specifies requirements that differ from §86.1806-05, §86.1806-07 and §86.1806-10. Where a paragraph in §86.1806-05 or §86.1806-07 or §86.1806-10 is identical and applicable to §86.1806-13 this may be indicated by specifying the corresponding paragraph and the statement "[Reserved]. For guidance see §86.1806-05." or "[Reserved]. For guidance see §86.1806-07." or "[Reserved]. For guidance see §86.1806-10."

(a) General

(a)(1) [Reserved]. For guidance see §86.1806-10.

(a)(2) [Reserved.]

(a)(3) An OBD system demonstrated to fully meet the requirements in §86.013–17 may be used to meet the requirements of this section, provided that such an OBD system also incorporates appropriate transmission diagnostics as may be required under this section, and provided that the Administrator finds that a manufacturer's decision to use the flexibility in this paragraph (a)(3) is based on good engineering judgement.

(b) thru (m)

(b) through (m) [Reserved]. For guidance see §86.1806-07.

(n) Diesel complete HD vehicles – requirements

(n) For diesel complete heavy-duty vehicles, in lieu of the malfunction descriptions of §86.1806-05(b), the malfunction descriptions of this paragraph (n) shall apply. The OBD system must detect and identify malfunctions in all monitored emission-related powertrain systems or components according to the following malfunction definitions as measured and calculated in accordance with test procedures set forth in subpart B of this part (chassis-based test procedures), excluding those test procedures defined as "Supplemental" test procedures in §86.004–2 and codified in §§86.158, 86.159, and 86.160.

(n)(1) *Catalysts and particulate traps*.

(n)(1)(i) If equipped, reduction catalyst deterioration or malfunction before it results in exhaust NOx emissions exceeding the applicable NOx standard+0.3 g/mi. If equipped, oxidation catalyst deterioration or malfunction before it results in exhaust NMHC emissions exceeding 2 times the applicable NMHC standard. These catalyst monitoring requirements need not be done if the manufacturer can demonstrate that deterioration or malfunction of the system will not result in exceedance of the threshold.

(n)(1)(ii) If equipped, diesel particulate trap deterioration or malfunction before it results in exhaust emissions exceeding any of the following levels: the applicable PM standard+0.04 g/mi; or, exhaust NMHC emissions exceeding 2 times the applicable NMHC standard. Catastrophic failure of the particulate trap must also be detected. In addition, the absence of the particulate trap or the trapping substrate must be detected.

(n)(2) *Engine misfire*. Lack of cylinder combustion must be detected.

(n)(3)(i) *Oxygen sensors and air-fuel ratio sensors downstream of aftertreatment devices*. If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding any of the following levels: the applicable PM standard+0.04 g/mi; or, the applicable NOx standard+0.3 g/mi; or, 2 times the applicable NMHC standard.

(n)(3)(ii) *Oxygen sensors and air-fuel ratio sensors upstream of aftertreatment devices*. If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding any of the following levels: the applicable PM standard+0.02 g/mi; or, the applicable NOx standard+0.3 g/mi; or, 2 times the applicable NMHC standard; or, 2 times the applicable CO standard.

(n)(3)(iii) *NOx sensors*. If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding any of the following levels: the applicable PM standard+0.04 g/mi; or, the applicable NOx standard+0.3 g/mi.

(n)(4) [Reserved.]

(n)(5) *Other emission control systems and components*. Any deterioration or malfunction occurring in an engine system or component directly intended to control emissions, including but not necessarily limited to, the exhaust gas recirculation (EGR) system, if equipped, and the fuel control system, singularly resulting in exhaust emissions exceeding any of the following levels: the applicable PM standard+0.02 g/mi; or, the applicable NOx standard+0.3 g/mi; or, 2 times the applicable NMHC standard; or, 2 times the applicable CO standard. A functional check, as described in paragraph (n)(6) of this section, may satisfy the requirements of this paragraph (n)(5) provided the manufacturer can demonstrate that a malfunction would not cause emissions to exceed the applicable levels. This demonstration is subject to Administrator approval. For engines equipped with crankcase ventilation (CV), monitoring of the CV system is not necessary provided the manufacturer can demonstrate to the Administrator's satisfaction that the CV system is unlikely to fail.

(n)(6) *Other emission-related powertrain components*. Any other deterioration or malfunction occurring in an electronic emission-related powertrain system or component not otherwise described in paragraphs (n)(1) through (n)(5) of this section that either provides input to or receives commands from the on-board computer and has a measurable impact on emissions; monitoring of components required by this paragraph (n)(6) must be satisfied by employing electrical circuit continuity checks and rationality checks for computer input components (input values within manufacturer specified ranges based on other available operating parameters), and functionality checks for computer output components (proper functional response to computer commands) except that the Administrator may waive such a rationality or functionality check where the manufacturer has demonstrated infeasibility. Malfunctions are defined as a failure of the system or component to meet the electrical circuit continuity checks or the rationality or functionality checks.

(n)(7) *Performance of OBD functions*. Any sensor or other component deterioration or malfunction which renders that sensor or component incapable of performing its function as part of the OBD system must be detected and identified on engines so equipped.

(o) Diesel complete HD vehicles – certification

(o) For diesel complete heavy-duty vehicles, in lieu of the certification provisions of §86.1806-05(k), the certification provisions of this paragraph (o) shall apply. For test groups required to have an OBD system, certification will not be granted if, for any test vehicle approved by the Administrator in consultation with the manufacturer, the malfunction indicator light does not illuminate under any of the following circumstances, unless the manufacturer can demonstrate that any identified OBD problems discovered during the Administrator's evaluation will be corrected on production vehicles.

(o)(1)(i) If monitored for emissions performance—a reduction catalyst is replaced with a deteriorated or defective catalyst, or an electronic simulation of such, resulting in exhaust NOx

emissions exceeding the applicable NOx standard+0.3 g/mi. Also if monitored for emissions performance—an oxidation catalyst is replaced with a deteriorated or defective catalyst, or an electronic simulation of such, resulting in exhaust NMHC emissions exceeding 2 times the applicable NMHC standard.

(o)(1)(ii) If monitored for performance—a particulate trap is replaced with a deteriorated or defective trap, or an electronic simulation of such, resulting in exhaust PM emissions exceeding the applicable standard+0.04 g/mi or exhaust NMHC emissions exceeding 2 times the applicable NMHC standard. Also, if monitored for performance—a particulate trap is replaced with a catastrophically failed trap or a simulation of such.

(o)(2) An engine misfire condition is induced and is not detected.

(o)(3)(i) If so equipped, any oxygen sensor or air-fuel ratio sensor located downstream of aftertreatment devices is replaced with a deteriorated or defective sensor, or an electronic simulation of such, resulting in exhaust emissions exceeding any of the following levels: the applicable PM standard+0.04 g/mi; or, the applicable NOx standard+0.3 g/mi; or, 2 times the applicable NMHC standard.

(o)(3)(ii) If so equipped, any oxygen sensor or air-fuel ratio sensor located upstream of aftertreatment devices is replaced with a deteriorated or defective sensor, or an electronic simulation of such, resulting in exhaust emissions exceeding any of the following levels: the applicable PM standard+0.02 g/mi; or, the applicable NOx standard+0.3 g/mi; or, 2 times the applicable NMHC standard; or, 2 times the applicable CO standard.

(o)(3)(iii) If so equipped, any NOx sensor is replaced with a deteriorated or defective sensor, or an electronic simulation of such, resulting in exhaust emissions exceeding any of the following levels: the applicable PM standard+0.04 g/mi; or, the applicable NOx standard+0.3 g/mi.

(o)(4) [Reserved.]

(o)(5) A malfunction condition is induced in any emission-related engine system or component, including but not necessarily limited to, the exhaust gas recirculation (EGR) system, if equipped, and the fuel control system, singularly resulting in exhaust emissions exceeding any of the following levels: the applicable PM standard+0.02 g/mi; or, the applicable NOx standard+0.3 g/mi; or, 2 times the applicable NMHC standard; or, 2 times the applicable CO standard.

(o)(6) A malfunction condition is induced in an electronic emission-related powertrain system or component not otherwise described in this paragraph (o) that either provides input to or receives commands from the on-board computer resulting in a measurable impact on emissions.